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POWER

Editor
FRED R. LOW
General Manager
IRVING FELLNER

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Cheaper Industrial Power

THERE is hardly a commodity or service for which the family or individual budget has to provide of which the cost of power is not a more or less important item.

And this becomes increasingly so as human effort is replaced by the motor and more machine-made products and mechanically produced services become a part of our daily life.

The electric industry has done wonders in reducing the cost of producing power. Not only are the best brains available employed in the design and operation of their stations, but scientific research, daring experiment and unlimited means have enabled them to push achievement nearly to the limit of attainable efficiency and to give their patrons improved service at constantly decreasing rates.

In the industrial field progress has been much less rapid and its managers have been slow even in taking advantage of the possibilities that the practice and experience of the central station have revealed.

Last year the industries of the country consumed about 200,000,000 tons of coal against 42,000,000 tons converted into electricity for sale. A reduction in the industrial coal and steam rate proportional to that which has taken place in the electrical industry during the last eight years would result in a saving of some 86,000 000 tons of coal annually.

This issue of *Power* is devoted in the main to articles showing how industrial plants can reduce their power costs.

The production and distribution of power are so involved with many of the other services and processes of the industries that re-organization along modern lines, taking advantage of pressures and temperatures now demonstrated to be safe and practicable and the apparatus available for their utilization, under an administration capable of co-ordinating the various services, would pay big dividends upon the necessary investment.

F. R. Low

POWER *Stands for...*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application

TIME was when the power engineer could feel well satisfied if his power house showed a generating efficiency comparing favorably with current practice. But today conditions are different. Industrial competition is so severe that care must be taken to see that over-all manufacturing costs are kept at a minimum, and the power engineer must do his part in effecting these savings. After a study of ways and means that could be adopted to this end, *Power* has determined that the most important are embodied in the program appearing on this page. These will be discussed in this and succeeding issues.

To say offhand that power should be generated or purchased in any given plant is likely to lead to false conclusions. While a more or less definite line of demarcation can be drawn usually between certain industries, according to their need for byproduct heat and steam, even those most competent to judge by experience often find it necessary to reverse their first impressions after analyzing all the factors.

It is necessary in all cases to satisfy the engineering problems involved, the economics, the financial aspects, and the reliability of service, any one of which may prove the deciding factor. The problem in an industrial plant must be viewed in its relation to production, for sometimes a shifting of process schedules will turn the scales in favor of privately generated power at a considerable saving.

Where complete operating records are available the task is simplified, otherwise, conditions must be assumed based on experience in other plants. Right here is where the selection of a competent consulting engineer is vital. He must be able to recognize and discount fictitious claims, whether they emanate from the power salesman or are based on assumptions by the operating force, and at the same time maintain a judicial attitude with his client's interest ever uppermost.

Power has always stood for making or buying power, according to which is the more economical in the individual case, all factors considered.

One of the factors pre-eminent in this country's industrial supremacy has been the recognition of obsolescence in its true proportions as distinct from depreciation. Starting with good materials and workmanship, followed by careful operation and maintenance, a machine at the end of ten, fifteen or even twenty years may continue to perform as efficiently as the day it was installed, yet advances in practice may have rendered it so obsolete as to make its retention a liability.

With machines of production this condition is usually so apparent that managements do not hesitate to discard the obsolete in favor of later developments of the art. In fact a manufacturer's very existence in a competitive field often rests on such action. The same holds true in the central station field, which, although not competitive, usually presents opportunities for large savings through use of the most modern equipment. The central stations have long recognized this and are continually relegating to the reserve units that have been in service only a few years.

In the industrial establishment, however, managements sometimes overlook the fact that power equipment is indirectly production equipment and is entitled to as much consideration.

Many manufacturers hesitate to modernize their power plants, even though they know

that relatively large savings would thus be made. The sticking point is in the investment required, for the money is either not available or there is reluctance to tie up capital that might otherwise be used to advantage in manufacturing operations.

There is a way, however, in which purchases of this nature can be financed. Various fields have adopted methods of delayed payment with eminently satisfactory results. Railroads fund the purchase of rolling stock by the formation of certificate-selling equipment trusts. Agricultural machinery and many other lines are sold on installments, often through finance corporations. And in the power field itself a few pioneers are selling their equipment to be paid for out of savings, as made.

Thus it is evident that the necessary methods are available for making easier the financing of equipment purchases. What is needed is that both makers and purchasers awake to the advantages that both can derive from such a course. And, on awakening, if they will act to relieve the burden of modernization costs by spreading the payments in some of the ways now used in other fields, there will be activity and profit for both.

Still the heat units go up the chimney and the power is dissipated in needless friction, although the equipment and methods for saving them, putting them usefully to work, are readily available.

Central station practice has clearly defined the path to be followed by the industrial plant in reducing wastes in the power house. Combustion equipment, choice of fuel, furnace design, automatic control, recovery of waste heat in the flue gases—these and many other problems are better solved in such large plants than in the average industrial unit.

In the transmission and application of power-house products—steam, electricity, compressed air, water under pressure, and other forms of energy—help must be obtained from another source. The plant that fails to conserve the heat or power available as byproducts from its manufacturing processes must learn from other, more advanced, plants and from equipment makers, of the methods and apparatus by which these wastes can be avoided.

Here is an opportunity for power engineers. The means are at hand. What is needed is a firm resolve that the heat units in the fuel consumed shall be used as completely as possible, in ways to decrease the final cost of power in the factory output.

Economical production of power depends largely upon two factors—the equipment and the operator. First-class equipment, improperly maintained and unintelligently operated, is likely to make a worse showing than poor equipment in the hands of skilled operators.

But how is an operator to know whether he is getting the best results possible out of his plant? Why is it that so often an outside consultant is able to detect waste and offer suggestions for improvement in operation? It seems to be a matter of perspective. The plant operator, however experienced, may be too close to the picture to detect all these opportunities. He is often too much occupied with details and operating routine.

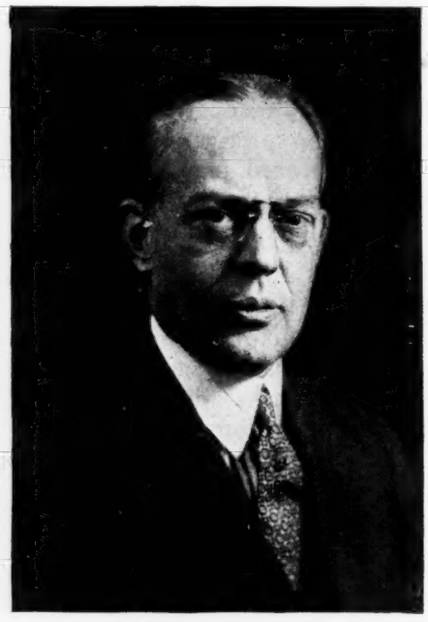
For this reason the chart offered by Mr. Myers for systematically analyzing plant conditions warrants reading and re-reading until it unconsciously directs the operator's thinking. Some of the suggestions may not be applicable to a particular case, others may have been applied already, but the plants are few that do not offer opportunities for employing one or more of the recommendations.

What is done with the products of a power house has at least as much influence on over-all industrial economy as the efficiency of the engines, boilers, turbines or auxiliaries. In fact, in manufacturing operations, the goal that the engineer must keep constantly before him is lowest cost of the finished products. This means close attention to the methods and equipment used for transmitting and applying in production work the various services generated in the power house such as steam, electricity, water pressure, compressed air, and refrigeration. It is ridiculous to generate these services at the highest efficiency that can be reached and then waste them right and left out in the plant.

It is with these thoughts in mind that F. M. Gibson has written the article appearing elsewhere in this issue. He also stresses one other point often lost sight of by power engineers—that it is possible to generate power too cheaply. The cost of operating the power plant can be so reduced that the demands of production cannot be met, and delay and loss results.

TO SUM UP: These points, together with the generation of power, are but different aspects of the same problem. They should be studied together, in the light of what is known of available methods and equipment. By so doing, the power engineer becomes better fitted for his most important job—enabling finished goods to be made at the lowest cost.

Purchased or Generated Power



An Economic Problem in Which Intangibles and Business Policies Count as Much as do Technical Factors

By W. A. Shoudy

Consulting Engineer, New York City and Associate Professor of Mechanical Engineering, Columbia University

PROBABLY no problem encountered by the power engineer requires more detailed study and sound economic judgment than does this constantly live subject. During the decade following the World War discussion has been stimulated by the remarkable advances made in the generation and transmission of electric power by the public utilities. Purchased power rates have been steadily declining, while no marked decrease has been observed in private power costs. The discussion at times has been academic, yet of all power problems this permits less of academic treatment than does any other.

"Our conditions are peculiar" is a phrase that is used by nearly every superintendent and plant engineer. The experienced consultant expects to hear it in the first interview with each new client, yet in most cases conditions are basicly similar to some one of his former problems except when the problem is that of purchasing power. For the latter is not a technical problem but an engineering one. It is an economic analysis of B.t.u., horsepower and kilowatts. The technical analysis forms the basis for discussion, but the engineering—that is, the economic—analysis determines the answer. Without both the answer is incomplete. Quite frequently, the engineer cannot make a final recommendation because of economic phases that he cannot know. Questions of business policy and probable future developments are not for him to decide. He can then only point out the alternatives so that the management can intelligently make the decision.

The technical analysis, though detailed, is simple and readily stated, but the economic discussion includes that indefinable quantity "business judgment," which is a highly trained intuition.

An analysis of the power supply problem divides naturally into three divisions: (1) Costs, arithmetical; (2) intangibles, experience; (3) business policy, intuition. The engineer can answer the first two divisions, but he can only advise on the third. The management must accept the responsibility for the last part of the problem.

Estimating Power Costs

Power costs can be accurately estimated. They are divided into two classes—operating costs and fixed charges. Detailed estimates of each division are desirable when possible, but sufficient data often are lacking, hence approximations are frequently necessary. Such approximations need not be misleading if judgment is used in estimating and analyzing. If those items which bear the greatest weight are determined accurately, the smaller items may be grouped together and approximated, thus greatly simplifying the process without materially affecting the accuracy of the estimate. Such a convenient grouping is as follows:

1. Operating Costs: (*a*) Fuel; (*b*) labor; (*c*) repairs; (*d*) miscellaneous.

2. Fixed Charges: (*a*) Interest; (*b*) depreciation; (*c*) insurance; (*d*) taxes. The arrangement in each group is in the order of importance. The *a*'s and *b*'s can be and must be accurately estimated; the *c*'s and *d*'s should be relatively small and can be approximated without serious error.

Operating costs are a direct function of operating hours. They can be entirely eliminated by shutting down the plant and discharging the men; they are bound to increase with the load and are subject to the human element. Good management will decrease, but load will increase, these costs. Fixed charges are determined by the original capital investment and continue till the plant is written off the books.

It is, consequently, essential that plant load and capacity be accurately determined, for load determines the fuel consumption and capacity the necessary capital expendi-

ture. Approximations are seldom reliable, and accuracy is essential if comparisons of private and purchased power are at all close. It is not true that comparisons based on the same load assumptions are necessarily just. If, for example, the peak load is assumed at too high a figure the actual cost of purchased power will be lower than the estimate, but substantially no effect will be shown in the actual cost of private power. The fixed charges on the private plant will be higher than necessary, though agreeing with the estimate.

It is equally important that, having determined the plant maximum, the cost of installation be determined with all possible accuracy. All items such as engineering and construction fees, supervision and interest during construction, testing, starting and preliminary operation are properly chargeable to the capital expenditures and thus increase fixed charges. When the equipment is in space that might be rented, the loss of rental becomes a part of the fixed charges. The chimney that passes through the floors of an office building occupies space that might otherwise be rented. Such loss of rental is properly a fixed charge that the private plant must carry.

When estimates of purchased power are made, the cost of power should include the fixed charges caused by capital expenditures for transformer, changes in type of motors or wiring systems, etc. Sometimes these expenditures are assumed by the power company, in which case they are included in the power rates.

Judgment developed by wide engineering experience is necessary in estimating fuel consumption. Manufacturers' performance guarantees are reliable within the limit of testing error.

Facility in technical computations and these guarantees are all the requirements necessary for determining the minimum fuel consumption of any projected plant, but the actual performance is determined by the human efficiency of the plant operator. Some years ago, David Moffat Myers said, "The efficiency of any plant is the *product* of the machine efficiency and the man efficiency." This phrase might well be inscribed over the entrance of every power plant. A 100 per cent plant and a 50 per cent man will have an efficiency of 50 per cent and a 100 per cent man, if he can be found, will cut the coal bill in half. Hence, we must know the type of man who will run the plant before we can determine how far from the theoretical the actual coal bill will be. It is this estimate of man efficiency that requires the experienced judgment. The plant engineer often errs in rating the man too high and the power salesman rates him too low.

The effect of load variations should be included in the calculated economy and not grouped with human efficiency. It is not the fault of the man, but of the factory conditions, which sometimes can be improved. Irregular loadings, while serious, do not account for the wide divergence between actual and theoretical efficiency. It is too often used as an alibi. Banking losses can be estimated and a variable load during steaming hours may account for a 5 or 10 per cent increase during those hours, and these factors should be included in the calculated minimum fuel consumption. This, divided by the human efficiency, gives a reasonably accurate estimate of fuel consumption that can be met when the plant operates.

> A 70 per cent plant and a 70 per cent crew will be as efficient as a 100 per cent plant and a 49 per cent crew. The added complications of a 100 per cent plant will probably reduce the efficiency of the 70 per cent crew to about 50 per cent. The 100 per cent plant will have higher fixed charges, hence the total cost of power will be more than with the less efficient plant.

Load Factor and Use Factor

The misuse of the term load factor is a frequent source of misunderstanding and frequently leads to inaccurate comparisons. Load factor is essential in estimating purchased power, but it must be fully understood if used in private power estimates. Use factor, or capacity factor, is a necessary part of private power estimates, but has no place in the purchased power bill.

Load factor is the ratio of the average load to the maximum load or peak for any given period. Hence it is designated as annual, monthly or daily. It is an attempt to describe the shape of the load curve; it indicates the type of peak and the hours of operation and the extent of banking periods. It is the basis of all rate making. When not mentioned in the contract the power company has assumed a load factor as a basis for the rate. It determines the maximum demand that the power company must supply, thus setting the capital expenditures that must be set aside to furnish the customer's service. The low-load-factor customer must pay a higher rate per kilowatt-hour than the high-load-factor purchaser, for the power companies' fixed charges are higher per kilowatt-hour in the first case than in the second, though the operating costs may be the same.

The load factor indicates the type of private plant that the designer must build. Low load factor suggests periods when repairs may be made on idle equipment, and that spare equipment may possibly not be necessary, that the highest fuel economy may not be justified and that low first cost will probably be necessary. High load factor implies no time for inspection or repairs (hence the necessity for spare equipment) and that high fuel economy and probably the most expensive type of equipment will be justified. The term then fades from the picture, for it does not enter the calculations of private power costs.

Use factor is the ratio of the average load to the maximum load that the plant can carry. It tells the degree of use that the equipment receives. If the peak load and the plant capacity are identical, use factor and load factor are equal, but in all other cases load factor is larger than use factor. Use factor determines the fixed charges per kilowatt-hour.

One thousand kilowatts at 50 per cent load factor represents a peak of 1,000 kw. and 4,380,000 kw.-hr.

annual consumption and gives sufficient data to compute a bill. But such a load factor suggests spare equipment for the private plant, say three 500-kw. turbines, making the plant capacity 1,500 kw., and although the load factor remains unchanged, the use factor is only 33 per cent. The private plant must earn fixed charges on 1,500 kw. capacity, but the power company on only 1,000 kw. Use factor is too often called load factor in power negotiations and leads to power estimates that are too high.

If the peak were 900 kw., a still wider divergence would result; 3,942,000 kw.-hr. would be purchased at 50 per cent load factor, but the private plant would require 1,500 kw. capacity because turbines are not built in 450-kw. sizes. The plant use factor would therefore be 30 per cent and the fixed charges per kilowatt-hour still higher.

If a mistake were made in estimating the peak for the latter plant and the actual peak was 1,000 kw. instead of 900 kw., there would be so small a change in the private plant fuel costs as not to be discernible, but the cost of power if purchased would be higher than estimated, because with the lower load factors the rate per kilowatt-hour would increase.

It is not enough to make the estimate for one year or for an average of several years, but rather for each year of the life of the proposed power contract or for as many years as the load can be forecast. Although the load factor may not change, an increasing maximum will merit a lower demand charge, thus reducing the purchased power rate.

The larger output of the private plant, even with an unchanging load factor, will increase the use factor until new equipment is added, thus reducing the fixed charges per kilowatt-hour, though the total fixed charges remain the same. Frequently, a plant that cannot be justified in the first years soon shows a handsome profit.

> **The answer to the purchased power problem usually lies with the plant engineer. His is a trying though interesting position because of the diversity of his problems. He must possess a high type of engineering talent, but unfortunately his employer is only beginning to recognize his usefulness.**

Intangibles

Those items which we are often too lazy to estimate are grouped as intangibles. They can never be accurately computed, but approximations of their money value can be made with a little effort. They are such items as reliability of service, ability to expand, necessity for supervision, labor troubles, other uses for capital, etc.

In some sections of the country reliability of service necessitates a private plant, but, happily, this condition has largely disappeared. The ease of adding power loads is an unquestioned advantage of purchased power.

Purchased power practically eliminates labor troubles and, when reliable, relieves the management from many annoying details, giving more time for attention to manufacturing problems. These are often sufficient reasons to swing the decision to purchased power, and the engineer should not fail to include these intangibles in his analyses.

Power is a part of the factory costs, hence capital expenditures in this department must show as large a return as in another. The larger the percentage that power bears to the total cost of the product, the greater will be the necessity for low power costs and the larger will be the opportunity for the well-designed private plant.

The central station's fixed charges are determined by the public service commission and seldom exceed 16 per cent. Improvements in design that will earn these charges are justified, especially since the earnings will increase with growing load, resulting in appreciable profits. They can therefore justify the purchase of the latest type of equipment and the considerable expense of the development work before and after installation. The private plant must be content with standard and proved equipment, because the first cost is lower and, second, because the period of tuning up is not only expensive, but may seriously interfere with production. The factory demands, first, reliability and, second, as high economy as can be obtained without sacrifice of reliability.

One may question the logic of grouping this item among the intangibles, yet engineering judgment can seldom be reduced to figures. Before selecting new designs, the engineer must balance the experience of the equipment manufacturer and his ability to correct troubles against the patience of his client during the starting up period. Such a problem can seldom be reduced to figures, and the engineer must carry alone the burden of his recommendations. It has been too often the case that a well-designed plant embodying advanced ideas has lost the owner's confidence because he did not understand the necessity of the long tuning-up period. A poor plant from a technical point of view would have started without trouble and have been a source of pride forever to the owners. In the first case the private plant is eternally damned and the future additions come from the central station. In the second the power salesman meets his greatest sales resistance.

The task of the central-station designer usually ends when construction is complete. The skilled operating crew takes over the plant and corrects the minor errors about which frequently the designer never hears, and often a serious error is corrected by the operator which the designer cannot handle. The private plant designer's work ends only when the promised economy and reliability are proved. The private plant must be designed for the crew that will operate it. A 70 per cent plant and a 70 per cent crew will be as efficient as an 100 per cent plant and a 49 per cent crew. The added complications of a 100 per cent plant will probably reduce the efficiency of the 70 per cent crew to about 50 per cent. The 100 per cent plant will have higher fixed charges, hence the total cost of power will be more than with the less efficient plant.

The engineer's sound recommendations are often revised because of business policy, unless he has been admitted to the inner circles and knows his client's plans

for the future. In such cases he can only place before his client or employer the facts as he finds them, but in a language that all fully understand. His language is as important as his slide rule. It is not enough that his computations be correct and his judgment sound, but he must tell his story in non-technical language so that his client fully understands his recommendations. It is his fault and his alone if the client draws the wrong conclusions.

The items that enter into business policy are so numerous that a complete discussion of this phase of our problem is impossible, but one or two specific examples may indicate the effect of business policy on technical recommendations.

An accurate survey of one plant showed that by a change of furnaces and the utilization of exhaust steam for process purposes, the resulting savings would wipe out the capital expenditure in five years, yet the decision was to purchase power. The major cost of the plant product was the raw material. Savings in manufacturing costs were, therefore, a small part of those that might be obtained in the purchase of supplies. Hence the purchase of this material was the most important factor in the profits of the company, and the investment in a private plant would tie up capital that might better be used in buying raw material at times of low market prices. Such decisions do not please the power engineer, for he likes to see the coal in the furnaces and the efficiency climbing, but the business policy is sound.

Quite the reverse conditions are illustrated by the case of a plant whose total power costs, including proper fixed charges, were slightly higher than purchased power estimates. The power company was noted for reliability of service and fair dealing with its customers, and the engineer strongly advised purchased power, but he was reversed. The company had ample funds waiting for investment. If operating costs might be reduced, they could get out a new product at a price sufficiently attractive to create a market and develop a new branch of their business which in a year or two would yield a handsome profit. Low operating costs for a year or two were essential and fixed charges were consequently practically ignored. A business gamble?

Policy of the Plant Engineer

How can the engineer answer this question? Are we not making a mistake in attempting to write a formula for this and many other engineering problems? Shall we use pulverized coal or stokers, uniflow engines or turbines, oil-fired boilers or Diesel engines? If these were technical problems we could write a formula that anyone could use, but they are engineering problems and need to include engineering and business judgment.

Although the plant engineer may not be permitted to decide this problem, he has an important duty to perform. He must first wipe away all prejudices and control his admirable desire to know because of his new plant's high thermal efficiency, because dollar efficiency is what he is paid to produce. His first interest should be the lowest possible power costs. If these can be obtained by purchasing power, he should be the first to so recommend.

He must be equally diligent in preventing his employer from rushing into a power contract because his plant has not produced the expected results. He must get the utmost from his plant—be the 100 per cent man even if he have a 50 per cent plant. Nor does his work stop there. He must be sure that the steam and kilowatts which he produces are fully utilized by the factory. No exhaust steam should escape to the atmosphere or to the condenser if low-pressure live steam is being used by the process. This condition is difficult to correct for it requires the highest type of diplomacy in educating the factory, but it often leads to greater results than the same effort expended in the boiler room.

Generating Power in a Department Store

THERE are undoubtedly many instances where it is profitable to purchase power. On the other hand, certain industries can make such use of the exhaust steam that purchased power is too expensive. Large department stores frequently fall in this class, although engineers often fail to understand the opportunities. In the Northern States heating is needed for nine months; all the year there are services needing steam. One store that discontinued the purchase of power is the Forbes and Wallace, of Springfield, Mass., and a story in a future issue will tell why and how they did it.

In the Southern States a different condition exists. Here little heating is ever needed, and frequently it is cheaper to purchase the energy needed and to use low-pressure boilers for heating.

Getting in Step With Progress

By D. D. Eames

Lockwood Greene Engineers, Inc., Boston

Engineers, as a rule, do not need to be told of the advantages and economies possible through the use of up-to-date equipment. But they sometimes find it difficult to convince managements who are not awake to the potential savings linked up with their power plants and power services. The author points out these possibilities in a way that cannot fail to arouse the interest of industrial executives.—EDITOR.

REHABILITATION of old plants offers one of the surest opportunities of reducing costs of steam and power. It is especially pertinent at the present time because there are so many plants in need of it. Since the war there has been a very general policy in industry of spending as little as possible on power plants and power services. Coincident with this has been a greater advance in power plant equipment and methods than for any other ten-year period. Those plants, therefore, which have not had the proper attention are in most cases grossly out of date and inefficient when judged on the basis of present-day attainments.

How Modernization May Be Effected

Modernization may be effected in different ways. New and up-to-date equipment may be substituted for the old equipment. Changes in arrangement and operation of the old equipment may be introduced to increase its efficiency. Improved facilities for production of byproduct power may be brought in. Modern ideas of plant centralization and interconnection may be worked out in such a way as to introduce large over-all savings.

An example of the first of these methods would be a boiler plant with low-set hand-fired boilers, possibly with insufficient draft, which was to be replaced completely with new boilers set and fired in accordance with up-to-date practice and with ample draft facilities. The fuel and labor saving of such a change would be extremely gratifying to the owners.

The second method might be exemplified by a boiler plant having good boilers but set with small and inefficient furnaces which were to be reset with proper furnaces and efficient firing, again producing most satisfactory results.

A concrete example of the third plan would be a textile finishing plant that was either purchasing its power or generating it with condensing units and at the same time supplying all the steam for power and hot water direct from the boilers. The addition of a back-pressure or extraction turbine to generate power equivalent to the demand for low-pressure steam would show savings of considerable magnitude.

Last of all might be considered a manufacturing establishment having two or more groups of factories, each group with its own separate boiler plant. If these plants were not too far apart, the modernization scheme would be to centralize all at one point, distributing steam to the other groups through long pipe lines. The savings of fuel, labor, supplies and supervision following such a change are usually large.

Modernization cannot always be justified in dollars and cents; in fact, it is frequently difficult to do so. The capital expenditure, with its inevitable burden of fixed charges, must be watched closely. The items that should offset the fixed charges and give, in addition, a return on the investment are principally the savings of fuel, labor and supplies. Usually, something more than fuel saving alone is essential to a favorable showing. Even the newest stations cannot often go the whole way in fuel-saving devices, not because of lack of capital, but because the fuel savings may not offset the fixed charges.

A logical plan of improvement should, however, in addition to fuel savings, show substantial savings of labor, supplies and administration expense, and to these direct gains must be added the intangible gains that invariably accompany a sound modernization program. For instance, people get out of a rut, plant operations are "pepped up," new ideas come in requiring at least a modicum of new thought, a pride in appearances and results developed. Any or all of these things mean better maintenance, more cleanliness, greater efficiency; in other words, cheaper power.

A Familiar Analogy

Consider by way of illustration an instance of modernization in a field outside of power-plant work. The routing of traffic in cities has been a great problem. Everyone will recall some particularly bad intersection that has been vastly improved by the installation of a rotary traffic system. The taking of land, safety islands and street surfacing for this system have doubtless been expensive, and while the advantages are tremendous and well worth the cost, the direct return in dollars and cents is hard to determine. The analogy might be carried further by reference to the discussion and careful planning that precedes these street changes and that should and usually does precede extensive power-plant changes.

The life of a fire-tube boiler installation may be set at twenty years. The exact period may, and often is, considerably longer, depending on the operating conditions. The length of life of water-tube boilers is not dependent on the same factors as that of fire-tube boilers and is usually much longer. When a boiler plant approaches its limit of safe operation, the insurance company will usu-

Fig. 1—Oil-fired boiler plant forming part of modernization of candy factory

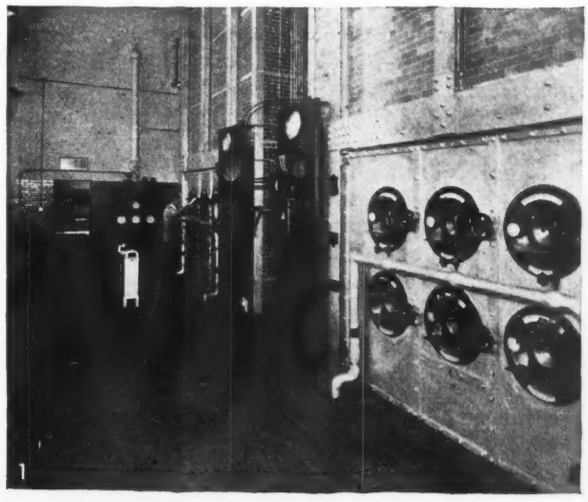
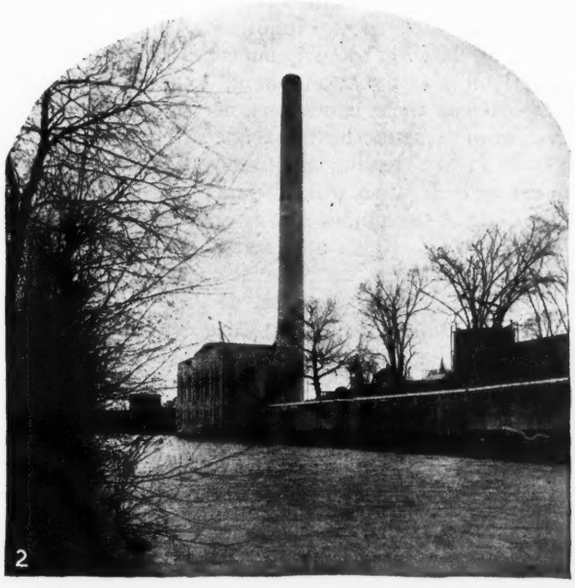


Fig. 2—This power house displaced two old plants serving a textile mill. Four large boilers replaced twenty-two and steam is distributed through 2,200 ft. of pipe line



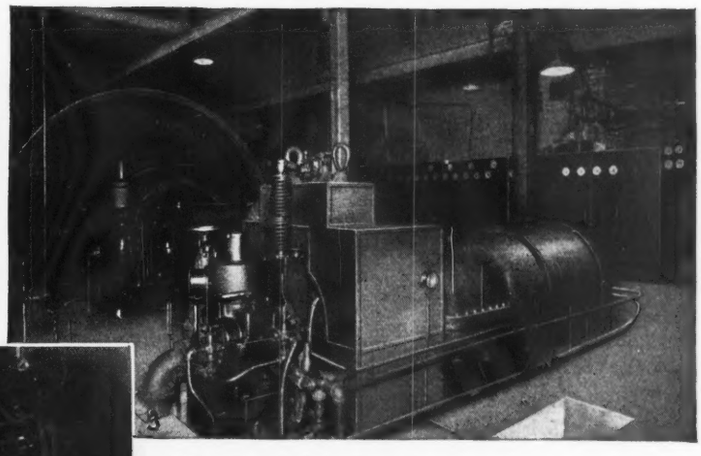


Fig. 3—Originally, the cross-compound engine furnished all the power. A 750-kw. low-pressure turbine with synchronous-motor balancing set was installed, the combination giving a low power cost. Later, a 1,000-kw. condensing turbine was added

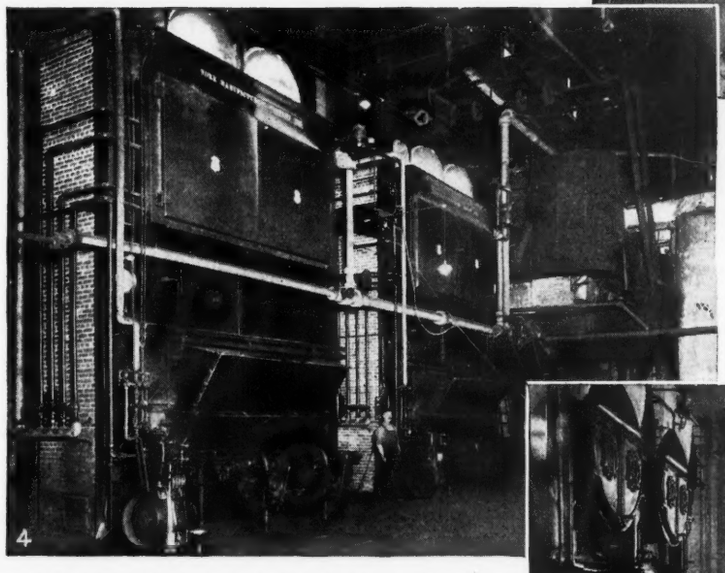


Fig. 4—This plant had 36 old boilers 24 of which were condemned by the insurance company. Modernization was effected by the installation of two 6,000-sq.ft. water-tube boilers with underfeed stokers

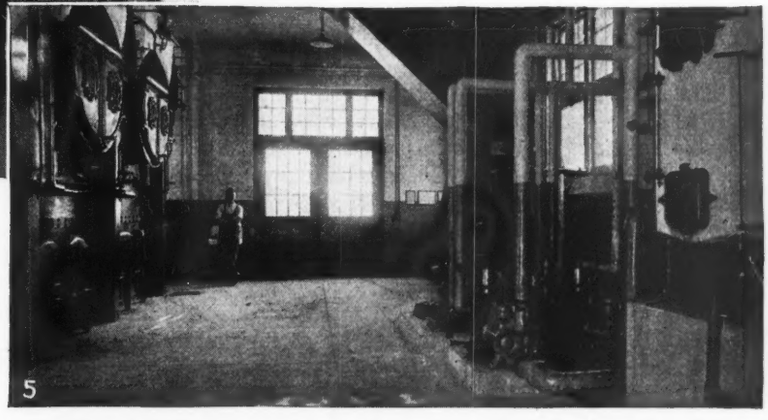


Fig. 5—This oil-burning plant, serving a charitable institution in a residential district, replaced an outgrown and inefficient coal-fired plant

Some Typical Examples of Modernization

ally impose a small reduction of pressure, 5 or 10 per cent. This is a warning, to be followed in a year or so by a much more drastic cut.

Replacement, interconnection with another plant or some other plan then becomes compulsory. At least it should be modernization in the true sense of the term, but often it has happened, through ignorance or other causes, that the changes put into effect are as wasteful and out-of-date as the old plant itself. Thus a large amount of money has been tied up and doomed to a small return, whereas a more judicious policy would have insured a more satisfactory result.

Central-station power commands a true and important position in industrial power today. In every modernization scheme it needs to be considered and accepted or rejected according to the merits of the case in point. In many cases adoption of central station power is the right answer to cheaper power, all things considered. On the other hand, many plants are today buying power that have no business to be doing so. They have simply followed the line of least resistance in deciding the question, without due study of the opportunities for savings that might be realized through power systems of their own.

The principal condition that makes for an opportunity of this kind is the chance to generate power as a byproduct of a demand for intermediate or low-pressure steam or warm water.

Better Use of Byproduct Power

This question of byproduct power has been described and discussed in recent years more perhaps than any other power-plant detail. It would seem as if there must at least be some measure of understanding of its benefits among all power-plant men. Yet it is surprising how few plants are really taking advantage of the idea to anything like the full extent of its possibilities. It is safe to say that the plants that are doing this are in a much better position to meet the close competition of today than those that are sticking to the old methods. Textile finishing plants, paper mills, leather factories are among the industries always in position to make byproduct power. A demand for large quantities of warm water for the process of manufacture makes an ideal condition. A demand for low- or intermediate-pressure steam coinciding with the demand for power makes another good condition.

The development of high-pressure boilers—that is, above 250 lb.—during recent years has aided materially in this respect. If the initial steam pressure is limited, for instance, to 200 or 250 lb., the back pressure will be correspondingly limited, thus restricting the application of the extracted steam to such services as can be successfully carried on with low-pressure steam. If, on the other hand, the boiler pressure is increased to 300 or 400 lb., the back pressure can be raised to, say, 100 lb. with good economy in the turbine and with greatly increased use for the steam.

It is interesting to see just how much power costs when produced as a byproduct of low-pressure steam. The thermal or heat equivalent of one kilowatt-hour is 3,412 B.t.u. If steam is passed through a turbine, at least this quantity of heat must be abstracted for each kilowatt-hour generated. On account of unavoidable losses in the turbine the actual amount of heat required will be 5,000 B.t.u. or thereabouts, and if this figure is still further modified by the boiler and furnace efficiency, the result will be about 7,000 B.t.u. as the equivalent in coal of one kilowatt-hour. This figure represents half a pound of coal, and may be contrasted with the two or three pounds of coal in industrial plants where exhaust steam is not used, or about one pound in the most efficient central stations.

The condition of the steam that has passed through the turbine can be analyzed as follows: Assume the initial pressure 150 lb. with 125 deg. superheat and the exhaust pressure 10 lb. If the steam should expand without loss of heat between these conditions, as through a reducing valve, it would be superheated about 220 deg. at the final pressure. If we assume again that it takes 45 lb. of steam through the turbine to produce one kilowatt-hour, the loss of heat per pound during the expansion process will be 110 B.t.u. This abstraction of heat for power generation will change the exhaust condition from 10 lb. pressure and 220 deg. superheat as given above, to dry saturated condition at 10 lb. pressure. If some superheat is wanted in the exhaust, or any other pressure than 10 lb., it can be obtained by a simple variation of the initial conditions. We have then as the result of the byproduct system one kilowatt of power for each 45 lb. of steam per hour supplied to the turbine plus 45 lb. of steam at 10 lb. pressure, suitable for heating water, drying cloth or performing a multitude of other useful operations. These figures may sound rather insignificant when considered on this unit basis, but in a going plant they will total large figures, representing worth-while savings in over-all cost of power and steam.

For instance, a certain worsted mill that runs on a 24-hour schedule, operates a 1,000-kw. turbine under steam pressure conditions approximately as mentioned above. The irregular demand for exhaust steam used directly in the dyehouse is evened out by the water-heating requirements for the finishing room. The turbine carries nearly full load all day. No steam goes to waste, but if the total demand for steam is less than the corresponding power demand, the excess of power is supplied from the purchased power lines. The outside power bills are very small under this arrangement, and the mill has a low over-all cost of steam and power.

Another and larger mill operates a 5,000-kw. back-pressure turbine under similar conditions and with similarly satisfactory results.

Modernization by Centralization

A few examples of actual cases will show what is being accomplished along this line. A mill in the South built a large finishing plant at a distance from the original plant, but was able to keep the power and steam production centralized by installing a 1,000-ft. pipe line to the new plant.

A mill in the North was able to eliminate two old and inefficient plants by building a new plant at the most advantageous point for fuel and condensing water, and installing a pipe line 2,200 ft. long partly outdoors and partly in tunnel and basements.

A metal-working plant in Connecticut modernized its steam plant at a central point by the installation of a distributing main of 1,500 ft., mostly in basements and tunnels.

A mill in Massachusetts, faced with the prospect of

replacing a plant of ten condemned boilers, was able, by the installation of a 1,200-ft. pipe line, to supply the steam from another boiler house, thereby making large savings of investment and subsequent operating costs.

A paper and leather plant operating three boiler plants in different factory groups is faced with condemnation of one of these plants. To save investment and reduce operating costs, the plan is being considered of concentrating all steam production in the larger and most up-to-date of the two remaining plants and installing a pipe line of 3,000 ft. to supply the demands in the other two plants.

All these cases of centralization will show good savings in cost of power and steam as the result of better fuel economy, reduced banking losses, reduced labor, and reduced administration attention and expense.

Selecting the Proper Equipment

The last decade has seen marked advancement in all kinds of power-plant apparatus. The aim of all the progress has been, in the last analysis, the reduction of cost of power or steam. The first cost of much of the new equipment is high and some of it is hardly suited to industrial plants unless in exceptional instances. On the other hand, many of the new ideas and much of the new equipment is so eminently suitable to industrial conditions that every plant should be prepared to make intelligent selection of those things that would be of value to its own peculiar conditions.

If one should attempt to classify the new equipment in the order of its money-saving value, we might say, without much fear of contradiction, that the development of the boiler furnace comes first. In the early days before combustion was well understood, it was thought that the closer the boiler to the fire the better the result. Gradually, the fallacy of this was recognized and furnace sizes began to increase. The primary object of the increase was to give sufficient volume, so that combustion would be complete before the gases came in contact with the comparatively cool boiler surfaces. Additional factors have been involved in producing the tremendous furnaces sometimes encountered in modern stations, but this is what primarily makes the improvement in efficiency.

The simplest application of the large furnace idea is to the h.r.t. boilers, which are the mainstay of the industrial plant. Boilers that used to be set 24 to 30 in. above the grates are now set at two or three times these figures and with noteworthy results. One small plant that had its boilers reset with a good furnace, reported after a month's operation that it was burning only half as much coal as before the change.

In addition to increase of size, boiler furnaces have undergone marked changes in construction. Refractory furnaces are and doubtless will continue to be the correct and usual thing for large numbers of plants. But even here improvements have come in. Better refractories have been developed, special refractory materials for particularly difficult places are available, better methods of laying brick are becoming more commonly known, better designs have been worked up. These things may not in themselves mean better efficiency, but they do mean reduced maintenance, smaller radiation loss and less cracking and air infiltration, all of which eventually mean cheaper power.

Cooling of the furnace walls either by air or water circulation has been found necessary to meet present conditions, and has been widely used. The cooling may be by circulation of air through passageways behind the refractory lining of the furnace or by circulation of water through tubes surrounding the furnace, these tubes being usually protected by some special facing on the side toward the fire.

The air-cooled walls should cause a direct improvement of efficiency because of the preheating of the air for combustion. They will also reduce the refractory maintenance and allow for a certain increase of capacity. The primary object of the water walls is not to improve efficiency, but to give greater capacity and greater continuity of operation. They do also effect an improvement in efficiency, but somewhat indirectly for the following reason: Better efficiency will result from a reduction in the amount of excess air supplied to the furnace for combustion. Reduction of excess air means higher CO_2 and higher furnace temperatures. In refractory furnaces the temperature that the brick will stand is the limiting factor on excess air. In water-cooled furnaces this limitation does not exist, and consequently higher CO_2 can be carried with correspondingly better efficiency.

Ten years ago the mechanical stoker was the accepted method of firing. Pulverized coal was in its infancy. Today stokers share with pulverizers this place of supremacy. Stoker design has been greatly improved during the ten-year period. At the beginning of that time stokers were short in length, without any suitable apparatus for disposing of clinker and refuse and with very imperfect distribution of air through the different parts of the fuel bed. There are many plants operating today with this antiquated equipment and wasting large amounts of coal in doing so.

The modern stokers are heavier and more rugged in construction than the old; they are usually installed much longer; they have clinker grinders or other means for continuous discharge of refuse; they have air distribution and zoning arrangements and accurate control of the coal feed to the various parts of the grate. The increase in length and the air and coal distribution and control are the most important factors in improving efficiency, and they have accomplished a great deal, not only in efficiency but in overload capacity.

Pulverized-coal systems are now standard equipment, having taken their place alongside stokers as a satisfactory and highly efficient method of firing. Maintenance costs of the pulverizers are relatively low and furnace maintenance will also be reasonable provided the furnaces have been designed with skill and with full appreciation of all factors. Pulverized-coal firing has some advantages over other types, principally in its ability to secure very close regulation of air supply and to follow changes of load quickly. There will also be smaller banking losses and a smaller quantity of refuse to dispose of. There are some disadvantages, on the other hand, and neither stokers nor pulverized coal can claim superiority over the other under all conditions.

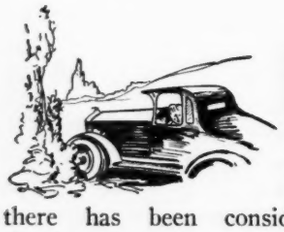
In any modernization program everything has to be considered together—fuel, firing, furnace, boiler and generating equipment—and a modernization project taking due advantage of these factors will not fail to show most substantial reductions in cost of power.

Let the Savings Pay

for Modernization

Installment buying has become widely accepted in the general merchandizing field, but has been applied to the power plant in isolated cases only. It offers large possibilities where lack of ready capital stands in the way of much needed rehabilitation. Certain modifications in the usual plan may be necessary to meet conditions pertaining to the field. The subject is here reviewed briefly in the hope of stimulating thinking and further discussion from both users and makers of equipment.

BY A. D. BLAKE
Associate Editor, Power



FEW fields present greater opportunities for effective savings through the installation of modern equipment than that of the industrial power plant. True, there has been considerable rehabilitation during the last few years, but the surface has only been scratched. In all industries and all sections of the country may be found obsolete equipment that is daily doing its share toward holding down profits. This likewise holds true for power services throughout the works.

Some managements need to be educated as to the potentialities of their power departments. Others appreciate the situation, but are unwilling or unable, in view of uncertainties in their particular industries, to make the necessary capital expenditures. It is conceivable that the resulting economies, both direct and indirect, might enable them to bridge these uncertainties and gain a lead on their competitors.

Why not, then, take a leaf out of the experience in other fields? If every man now possessing an automobile had waited until he had the cash in hand before purchasing one, there would be several million fewer cars on the streets today, fewer people would be experiencing the convenience and benefits, and the automobile industry would be in a far less prosperous condition.

Sewing machines, musical instruments, washing machines and various electrical appliances have long been sold on the installment plan, and it has proved profitable to both manufacturers and purchasers. The idea is old, but that it has not been more generally applied to the power field is partly because it has not been sold and partly because certain inherent complications have been greatly magnified.

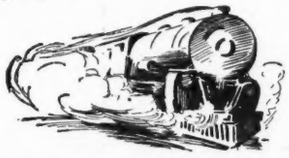
All doubts as to the soundness of installment buying were dispelled in that remarkable address of Prof. E. R. A. Seligman, last winter, which received such wide publicity and in which he related the results of a two-year investigation into the subject. In his conclusions Professor Seligman predicted that "if credit is restricted to the proper commodities and the right kind of individuals, installment buying will stand forth as one of the most signal contributions of the Twentieth Century to the potential creation of national wealth and welfare."

It is true, as some will point out, that the products mentioned are in a sense luxuries, they are consumer products, but the same procedure has been applied to articles of production. For years farm implements have been sold on credit and the railroads have been accustomed to issue equipment trust certificates to permit the purchase of new rolling stock. These latter have been very successful and are recognized as legal investments by many states. In each case the equipment is enabled to pay for itself through increased savings or increased production.

The plans may differ in detail but are similar in principle. Why not apply the principle more generally to the power field? In a few isolated cases it has been applied. One steam-engine manufacturer has built up a lucrative business by taking payment for his product directly out of the savings effected. A well-known oil-engine builder has found such a "saving payment plan" equally successful. It, of course, involves an accurate knowledge of what the product will do and a careful survey of conditions to be met, but this is usually not difficult. That more manufacturers have not followed this plan is surprising. It has large possibilities, as is shown by the experiences of those who have employed it.

Some equipment manufacturers are reluctant to accept notes in payment for their products because the banks, as a rule, do not want to take long-term paper and do not consider such purchaser's notes liquid. In such cases the finance corporation offers an alternative. It is often the only vehicle through which small notes may be accumulated, collections followed up and banking support obtained. One firm in the field has increased its sales enormously through adoption of a plan whereby notes are taken in payment and turned over to a finance corporation.

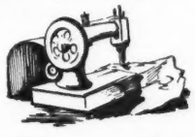
An objection which some equipment manufacturers see in this method is that they must indorse the purchaser's notes. In case of non-payment the finance company turns to them for the unpaid balance, and they, in turn, must obtain satisfaction, if any, from the purchaser. Thus it imposes a contingent liability upon the manufacturer until all payments are met. However, this is an obligation that every merchant should be expected to assume. The finance company has no set-up for disposing of used equipment of this character, whereas the manufacturer can readily handle it. Moreover, the actual liability is only the loss sustained through such repossession.



For equipment such as boilers, where the installation costs may run well up to the cost of the bare boiler, these financing methods may not be as attractive as in the case of self-contained units such as oil engines, pumps, steam engines, etc. While this plan is likely to be a little more expensive to the customer, it has certain advantages where the equipment manufacturer is not in a position to do his own financing.

These instances deal, however, with single units of equipment. When a whole plant is considered, the problem becomes more complicated, but not insurmountable.

A firm of consulting engineers, adequately financed, might undertake to rehabilitate or install power plants on the basis of taking their payment out of the savings or in fixed installments, they in turn underwriting the projects and making suitable terms with the equipment manufacturers. In each case a careful survey of conditions would be necessary in advance. This plan has the advantage of insuring a free hand in the selection of equipment.

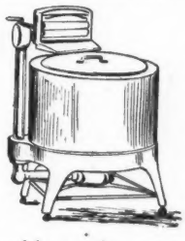


The idea might be carried out by a large manufacturer making a fairly complete line of power equipment. This would involve the maintaining of an adequate engineering staff, which at times might not be fully occupied. The plan is now being followed by one of the large manufacturers of electrical equipment in Germany.

Still another procedure involves the collaborating of a group of equipment makers whose products go to make up a complete plant. This would necessitate the retention of a consulting engineer to make the initial survey and work out the plans. It would have the advantage of distributing the engineering cost, and in this respect might prove cheaper than as at present, where the engineering demanded by the customer is often unwarranted and expensive. From the customer's point of view this plan has the disadvantage of eliminating competitive equipment.

Many equipment builders take the position that they are manufacturers and not financial organizations. Any installment payment plan is essentially financial in its complexion. This leads to another possible solution, involving a financial organization that would permit the purchaser to select the equipment and accept his notes for the total, the payments to be on an agreed basis and the financial house to exercise supervision in the selection of the machines purchased. Collateral trust certificates issued against such notes would permit fairly attractive financing without requiring excessive capital originally. They would obviously find greatest application where the projects involve relatively large sums of money.

Such a plan might eventually lead to the financial house becoming interested in various manufacturers. If a builder has the financial means, the transactions could well be handled by his own financial company. This is being done at present in a limited way, but none of these financial organizations has issued collateral trust certificates. This method has the merit that the manufacturer is in a position to sell on a savings basis, and his financial branch will handle the paper without too much red tape.

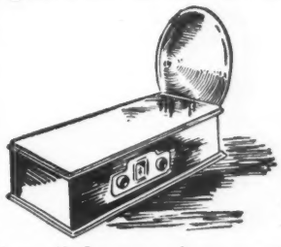


In discussing the subject recently with an executive of a large finance company, some points of experience in the automotive field were brought out. One is of especial interest and worth quoting, although perhaps not comparable to the power field. He said:

"When finance companies were first organized, there was quite a little agitation about the unsoundness of financing the time sales of so-called pleasure automobiles. The agitation, however, was not so strong with respect to trucks, or so-called articles of general utility.

"It later developed that one or two finance companies who specialized in the handling of truck financing, incurred excessive losses on this business, while those who had the greater proportion of their business confined to passenger cars developed better than normal loss ratio.

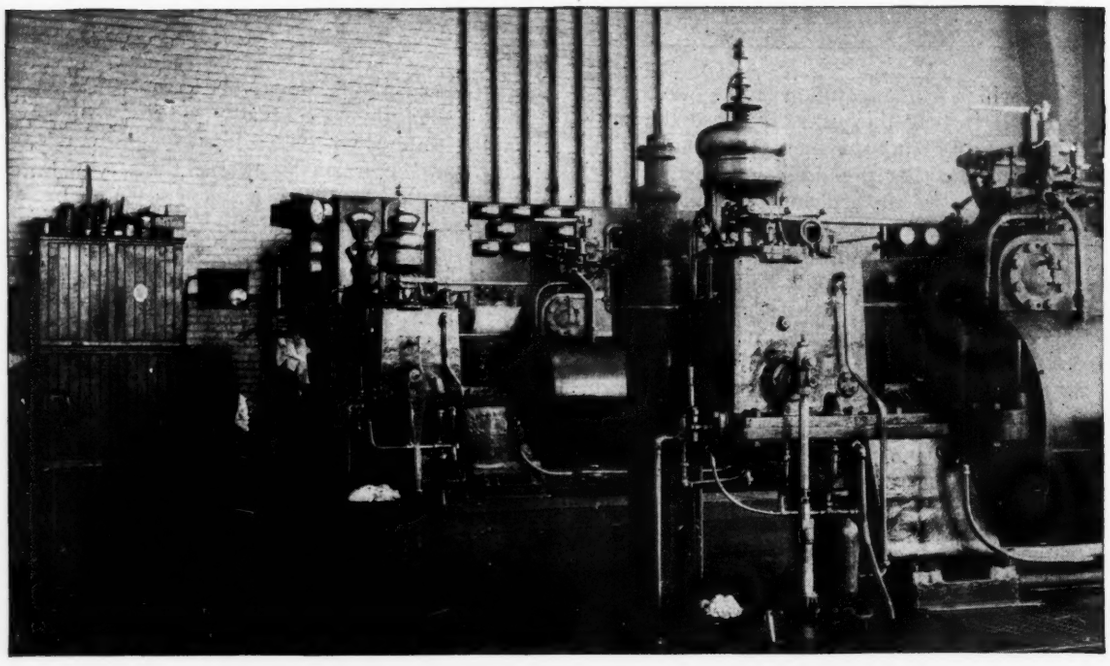
"The reason for this was that the man who was buying a passenger car had some other source of income out of which he could make his payments, even though the passenger car might have been in an accident or might not have been in use for a period of time because of weather or other conditions; whereas in the case of the truck, the purchaser in many instances had figured out carefully what his income from the truck would be and what he expected his expenses to be, but he did not have any outside income to take care of the payments on the truck in the event of unforeseen happenings. The result was that if he lost his contract for hauling gravel or was not able to secure additional contracts that he had figured on, or if the truck broke down, the earning power of the truck was curtailed and he could not make his payments, and the finance company was forced to repossess.



"However, the thing that stands out chiefly is the fact that all finance plans must start off on the basis that the one to be used with reference to the specific article must be sound from the credit angle. This means that the purchaser should be in a position to take care of the payments, even though unforeseen events occur which would cut down the earning power of the equipment."

The subject is one of broad possibilities both to the manufacturer and to the purchaser. To the former it means increased business and to the latter it means substantial savings, which assume their rightful importance if interpreted in terms of increased profits.

Further progress in this direction will be accelerated by frank and free discussion of existing practice and its extension with such modifications as may be necessary to cover the field as a whole.



Two units run parallel in a bleachery, one condensing and the other non-condensing

Power and Heat Wastes

Can Be Reduced by Good Engineering

By Warren B. Lewis

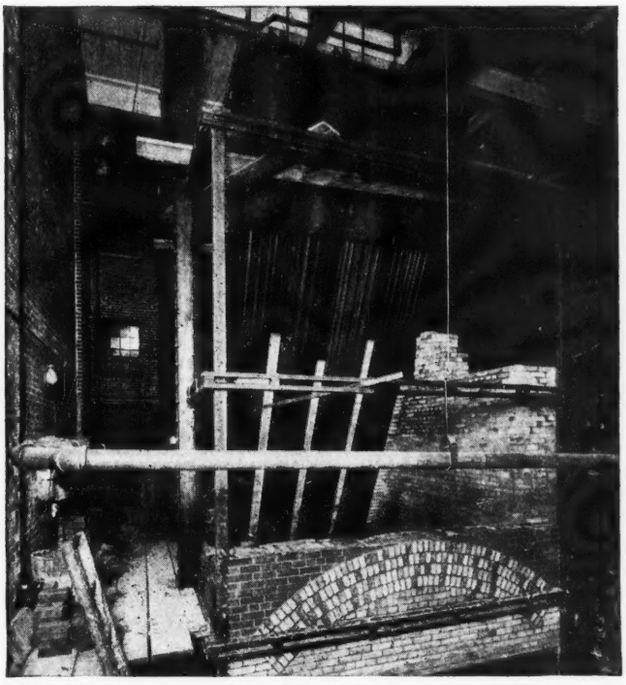
Consulting Engineer, Providence, R. I.

TO ONE who has been for twenty-five years and more familiar with the engineering problems of mill production, one of the most interesting developments of the last decade has been the radical change in market conditions which, in turn, is necessitating equally radical changes in methods of production if profits are to be prevented from disappearing. The index of wages has risen to greater heights than the index of manufacturing selling prices; the tools of production have overrun demand, competition is keener, and in many industries the mill selling price provides a very small margin over mill cost.

Many mills originally designed to do specific things have expanded their lines and are directly competitive where once they were not. Inventories are decreasing, quick delivery is an essential factor, and rapid service is as important as cut prices. It is not uncommon to find part of the machinery in a mill idle while other parts run overtime, resulting in an upset in the balance of departments.

All this presents new engineering problems, and the new condition must be met by intensive studies of machine production, transportation both interior and exterior to the mill, the utilization of raw materials with the highest efficiency—all to bring about a decreased cost per unit of production combined with quick processing and quick delivery. Mills are going out of business and properties being liquidated because of inability to meet these new conditions either physically, financially or temperamentally, and the survivors are those who realize that money must be spent in order to be saved.

This article deals with just one item which might be termed the proper treatment of the B.t.u. In the coal pile or the fuel-oil tank is potential energy which must be paid for from the profits of processing; or to express it another way, a certain amount of real estate, machinery, labor, executive and engineering effort must be used to pay for the energy in the fuel, and whatever is wasted represents useless effort and non-productive capital. Not all the potential energy in the fuel can ever be made wholly useful, and economy in its use must include the cost of producing that economy. In this article an attempt is made to outline some of the wholly practical things that can be done to utilize heat with reasonable efficiency and that are in no sense experimental or purely theoretical.



This 5000-sq.ft. water-tube boiler replaced several obsolete boilers with which the flue temperature frequently reached 700 deg. F. The new boiler gives a temperature in the flue never over 500 deg. F. and mostly below 475 deg. F.

Nearly every mill man is more or less familiar with the changes that have taken place in boiler plants, particularly in the field of public utilities. Mill conditions are quite different from those in the large power plants, but many of the lessons learned in the latter can be applied to the industries to advantage. Stokers, pulverized fuel, furnace design, superheat, automatic control, recovery of waste heat from flue gases are all applicable to industrial plants to a greater or lesser degree, dependent upon individual conditions. As important as anything is the development of instruments and devices that make steam generation a matter of knowledge rather than guesswork.

Hand-fired boilers operating at average efficiencies of from 60 to 65 per cent are being replaced with large units mechanically fired with average operating efficiencies of 75 per cent. Flue gases that were formerly discharged to the atmosphere at temperatures of 600 to 700 deg. F. are being utilized to heat water for boiler feed and process purposes; and a still later development is the heating of air for use in the furnaces.

It is quite within the bounds of practice to utilize flue-gas-heated air for ventilating and drying purposes, particularly in industries where a large amount of heat is required for the evaporation of water in process work. Some of the more progressive mills are today making the largest volume of product in their history with a substantial decrease in the amount of fuel used, through economy in the boiler room alone.

Where a gross return of 25 per cent on the necessary expenditure is indicated, there would seem to be no justification in inefficient operation.

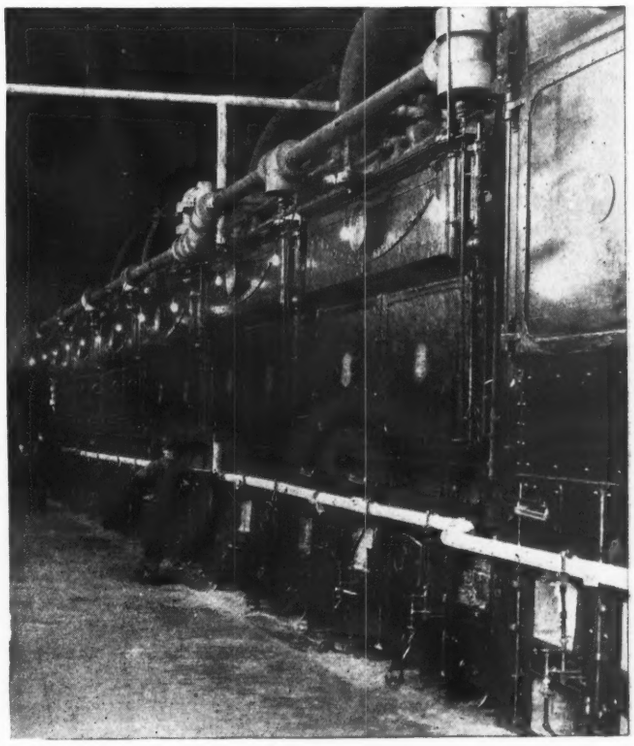
The high efficiency of the modern public utility power plant is due in part to continous operation over a long period of time without the alternate heating and cooling of furnaces characteristic of the mill load. Many of the newer devices for collecting heat that would otherwise be wasted and for returning this either to the boiler or the furnace may have undoubted value in the public utility plant, but have a questionable value in the mill plant. This does not mean, however, that they are never applicable in the latter case, and in many instances a highly developed mill boiler plant may result in a lower cost per pound of steam used, though the first cost may be high.

Many manufacturers have little interest in investing money in boiler plants because the cost of steam is a small percentage of the total cost of the finished product, but if the actual saving in dollars produces a generous income on the money invested, then the question of percentage of production cost might well be overlooked.

Coal pulverizers and burners have been developed to a high degree of reliability, and repairs per ton of coal burned are very low. The response to steam demands is almost as good as with oil or gas and one need have no fear today that a pulverized-coal installation is in any way experimental or uncertain of results. Air preheaters are an established fact and may well be considered for heating air for use in dyehouses, paper mills and those industries where the absorption of vapor is essential to careful manufacturing.

Woolen mills, paper mills and bleacheries are examples of industries in which a large amount of heat is required in processing. Many mills using no heat in processing require a considerable amount during the winter season

This row of boilers was converted from hand-firing with coal to oil-firing. The cost of the change was $50,000, which was fully repaid by the savings made in the first two years



for general heating purposes. Many processes that were once done with high-pressure steam can be done with low-pressure; and the proper utilization of fuel is where mechanical power can be produced through the loss of a very small part of the heat in the steam and the remainder of the heat efficiently used for processes.

Dye kettles can be operated with low-pressure steam and the water introduced into them preheated with low-pressure steam, with a consequent saving in time and the production of mechanical power at an exceedingly low cost. Drying cylinders in woolen, paper and bleachery plants can be operated with exhaust steam, and in many cases it is highly economical to increase the drying surface in order to maintain production when using low-pressure steam. Many industries use large amounts of hot water intermittently, and this can be derived through the use of low-pressure steam exhausted from a prime mover with a smoothing out of an otherwise erratic draft on the boiler plant.

Cotton mills almost universally have been heated with live steam, at perhaps reduced pressure, principally because the power plants were designed to operate at the highest steam economy irrespective of any other uses of steam. Such mills can be heated with low-pressure steam exhausted from a non-condensing prime mover with a reduction in the mechanical load on the main units and a net saving in the fuel used. An interesting example of this is in a cotton mill where a large amount of power was being purchased during the winter season because the boiler plant was not sufficient to operate the main generating units and heat the mill. A suitable generating unit was installed to operate in connection with the heating system, with a result that 500 kw. of energy was made available with no perceptible increase in the output of the boilers, and the money value of this increased output paid for the entire installation in less than two years.

In another cotton mill the heating system, which had always operated with live steam, was altered to use steam at less than 5 lb. pressure bled from one of the main units, with a reduction in the boiler load of 20,000 lb. of steam per hour.

A well balanced bleachery can derive all its mechanical power through the simple act of passing steam at boiler pressure through a suitable generating unit on its way to driers, dyeing machines, etc. The same thing is true in many woolen and worsted mills. One might lay down as a general rule that every machine and every process that can operate with low-pressure steam should be so designed or rebuilt, and that this steam should then be obtained from a prime mover that will deliver the maximum amount of mechanical power per given amount of steam passed through it.

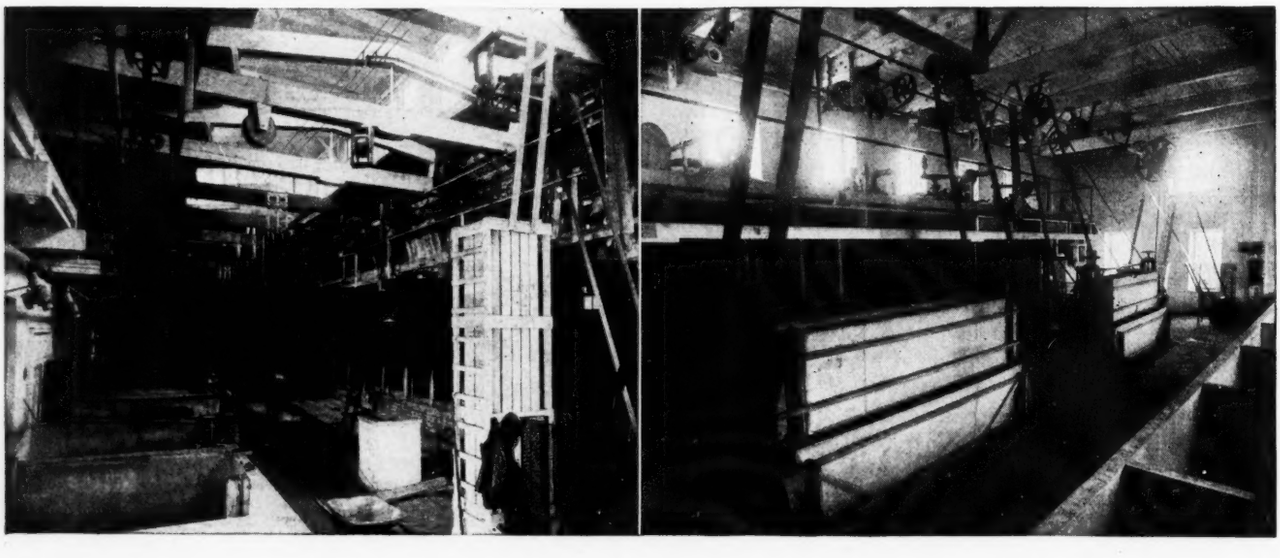
Much of the apparatus that has been in use for a number of years was originally designed to use steam at pressures higher than practical exhaust-steam pressures. In many cases such machines can be altered or added to so that low pressure is suitable, and certainly all new machinery purchased should be suitable for use with low-pressure steam.

A development of the last few years has been in turbines taking steam at boiler pressure and exhausting at comparatively high pressures, 50 lb. or more; and while these turbines are in themselves comparatively inefficient, they actually produce mechanical power at almost no operating expense other than for repairs. The tendency to increase boiler pressures in order that main power units may operate with lower steam rates has made the use of these non-condensing turbines an important factor in over-all economy.

Power Generation

In those mills where a power unit is the chief user of steam and but little process steam is required, the use of higher boiler pressures and higher superheat is strongly indicated. A pressure of 150 lb. has until recent years been considered fairly high for ordinary mill plants; but it has been demonstrated that pressures of 350 lb. are entirely practical, and the cost of coal per kilowatt-hour in these high-pressure plants has been

These two pictures are before and after modernizing in a linen bleachery. The trim appearance noted in the "after" picture is largely due to the elimination of obsolete and excess equipment and the simplification of the layout



greatly reduced. A 1,000-kw. steam turbine utilizing saturated steam at 150 lb. initial pressure may produce a kilowatt-hour for 18 lb. of steam admitted to the turbine. The same-sized unit utilizing steam at 350 lb. pressure and 150 deg. F. superheat may produce a kilowatt-hour for 10 lb.

Those plants approaching the time when boilers must be replaced cannot afford to ignore the tremendous reduction in fuel cost per kilowatt-hour made possible through experimental and research work which has been carried on by the public utilities. If prime movers are not suitable for use at these high pressures, it is possible to interpose a turbine taking steam at 350 lb. and exhausting at 150 lb. into the existing prime movers so that it does not become necessary to rebuild the entire plant.

Condenser Water

The recovery of heat from condenser water is a problem that has racked the brains of engineers for years. There are industries that use large amounts of hot water, and if the amount is in excess of the water required for condensing purposes the problem is comparatively simple. This condition is found in worsted and woolen dyehouses; and a number of plants are now using all the condensing water, recovering probably the very highest percentage of heat entering the generating unit. This is particularly valuable in winter when river and pond temperatures are low and a large amount of steam is required to raise the temperature of water to the boiling point. If water is recovered from the condenser at a temperature of 100 deg. F., there is a great gain over using water at a temperature of 40.

In some plants condensers are operating at varying temperatures and vacuums, depending upon manufacturing needs; and in others comparatively low vacuums are maintained to provide higher temperatures in the condenser water. Automatic regulation of the temperature of the condenser water is easily accomplished so that with varying loads on the prime movers correspondingly varying amounts of water can pass through the condenser.

As a rule adequate hot-water storage is necessary, but in those industries where there is a constant use of hot water, the storage need be only sufficient to provide for temporary fluctuations.

Woolen mills have utilized this system of heat recovery for a number of years, but in most cases it has been very inefficiently done.

General Heating

A by no means small amount of fuel is required to heat a manufacturing plant unless the process carried on provides the necessary temperature. Most mill heating is very inefficient owing to no automatic control to vary the use of steam with changing outdoor temperatures. Unit heaters with automatic thermostats have become popular and present excellent possibilities in the efficient use of heat. Hot-water heating systems possess many advantages in the matter of control, particularly when combined with power units. An interesting and rather unusual example of this is in a mill where the condensing water for one of the units is circulated through the heating system with a net saving to the mill of $100 a day during the coldest weather. Perhaps the chief objection to the hot-water system is its first cost, but in the efficient use of heat it possesses characteristics that are of great advantage.

The boiler load in a cotton mill varies greatly between summer and winter because the heating is a fairly large item and boiler capacity must be provided. The same is true in metal-working plants, particularly those in which considerable ventilation is required. Steam for the heating system can be passed through non-condensing turbines, and the power so generated will be deducted from the main generating units, reducing the load on the latter and hence the amount of steam they require. The total boiler capacity with such a plant will be lessened, as will also the cost of operation. An arrangement of this kind is comparatively inexpensive and requires no radical change in the main power plant.

Ventilation

In the paper industry systems of heat recovery from vapors from drying cylinders have been used, but nothing has been done in the textile industry along this line. The most common way of ventilating dye kettles, drying machines, etc., is to exhaust air and vapor through a simple disk fan to the atmosphere, which causes an inrush of cold air which must be heated to room temperatures. This frequently sets up condensation troubles which have to be met with special vapor absorption systems. If the air laden with moisture, arising from dyeing and drying machines, was passed through apparatus similar to a "Briner" economizer, in which outside air is heated by the exhaust vapors, there would be a recovery of a large amount of heat and lessened disturbance of general air conditions. The actual loss of heat in the processes mentioned is enormous, and this is a prolific field for the development of an apparatus that would be simply a heat exchanger.

The hooding of machines giving off large amounts of vapor reduces the amount of air that has to be moved and hence the amount of fresh air that must be heated. While generous use of ventilating fans appears to be a simple method of removing vapor, more often than not excessive drafts of air are created and complicate the problem. The ideal machine would be one in which vapors were condensed as rapidly as released and no air used for the purpose of carrying the vapors away. The only machine built on this principle with which the writer is familiar is the Minton vacuum drier, in which paper is dried in a vacuum-type chamber from which all air has been exhausted. With this machine no vapors can mix with the air in the room, hence there is no ventilating problem. This machine has not as yet been introduced into the textile industry, but it merits serious consideration where high capacity and uniform drying of goods is essential.

Temperature Control

A great source of waste is in uncontrolled boiling operations. It is not uncommon to see dye kettles, boiling-off vats and similar machines giving off enormous clouds of vapor, though all that is needed is to keep the solution boiling. Some control of this waste is realized through the use of steam meters, but automatic control eliminates the human element. If agitation is needed, it had better be done mechanically rather than through violent boiling. A combination of automatic control and of recovery of heat from vapors would in many instances

reduce the fuel cost of an operation about two-thirds.

Few plant executives realize the great waste of heat resulting from the lack of automatic control of heating systems. Steam is frequently turned into a system in the cold days of the fall and remains on the system until the mild days of spring, and room temperatures are crudely regulated by opening and closing windows.

The writer once investigated this in a large plant, and for a period of one month in the winter controlled heating coils by hand, employing a man to make continual rounds of the plant four times a day, turning on and shutting off steam as seemed to be necessary to maintain working temperature. The reduction of steam used in the heating system in that particular case was nearly 50 per cent. If it is remembered that there are few days during the heating season that the entire heating system is needed, then the waste of keeping it filled with steam is at once apparent. Unfortunately, automatic control systems for coils and radiators are expensive and it remains for someone to devise a simple and comparatively inexpensive control that can perhaps take its motive power either direct from the steam mains or from the electric wiring system. The automatic control of bleaching kiers, paper-mill bleach boilers, drying rooms, boiling-off and dye kettles and similar machines has been proved highly successful from the viewpoints of operation and reduced costs.

Auxiliaries

Many power plants, well-designed with regard to steam generation and power units, utilize a large number of steam pumps that exhaust steam in excess of that which can be used. Where the steam rate of the unit may be, say, 16 lb. per kw.-hr., it is not uncommon to find auxiliaries using so much steam that the over-all rate is so high as to offset to a considerable extent the high economy of the main unit. Motor-driven auxiliaries, air compressors, process pumps, etc., will in many cases operate with one-half the steam, referred back to the boiler. If a large amount of exhaust steam can be used, it would best be taken from the main unit, where the amount of mechanical work done is greater for a given amount of steam passed through, than to take it from numerous small units giving up very little mechanical power for the same amount of steam used. Certain types of plants utilizing many small engines and steam pumps have been rebuilt with most satisfactory results arising from the concentration of power in a single unit.

Where a high degree of reliability is essential, it may be advisable to drive auxiliaries through combined steam and electric motors so that either one or the other may be used. This is frequently done in public utility plants in order to maintain heat balance.

A great advantage in the use of motor-driven auxiliaries is in the reduction in the amount of piping necessary, this in turn reducing heat losses. In every plant an analysis should be made of the amount of steam utilized by main units, auxiliaries and for process work, reducing each to its lowest possible terms as expressed in B.t.u.

Cost of Power, Light and Heat

If one recognizes that all power, light and heat used in a plant are simply various forms of manifestation of the heat in the fuel, then it becomes apparent that there should be some relation between the amount of fuel used and the amount of product manufactured. For a given plant output the amount of fuel used should bear a certain relation as long as there is no material change in the processes employed. This relation will change with varying percentages of plant output, but it is frequently possible to establish a relationship which can be put into the form of a graphic chart. This having once been determined from records kept over a period of time, it is possible to predict how much fuel will be used for all purposes if the volume of product is known. Such a chart is a constant check on the operating efficiency of the mechanical department and enables those in charge to investigate the reason for any deviation.

The writer has kept such charts for cotton piece-goods finishing plants, showing the relation between the number of yards processed and the amount of fuel consumed for varying percentages of plant output. Improvements in plant operation and economies introduced are at once apparent, or inefficiency in operation is quickly detected. Such a chart may have to be revised from time to time as methods of manufacturing are materially changed, or if the plant increases its capacity.

An interesting fact which is shown by such a diagram is the stand-by loss of heat. The writer is familiar with instances where 30 per cent of the total boiler capacity is required to maintain pressure in the piping systems without a machine being in operation. This not only represents a great burden on operating costs, but represents an investment that is wholly out of proportion to real earning capacity. The establishment of such a record provides proof of the economies to be realized from improvement in the operation of a mill power plant with all of its ramifications, and presents to the executive head a concentrated report on plant efficiency.

If the mill be a paper mill, this chart would show the relation between tons of paper manufactured and pounds of coal burned. If it be a cotton piece-goods finishing plant, it will be yards processed against coal burned. If it be a woolen mill, it will be yards manufactured and finished and coal burned. The writer does not claim that this relationship can be made exact, but an average condition can be established and will be a valuable guide to those accountable for the money spent.

Modernizing Steam Distribution Saves Money

Many a plant could cut its costs if full advantage were taken of modern knowledge, methods and equipment. Vassar college revamped its system of distribution for heating steam and saved 2,000 tons of coal per year even though a 10 per cent increase in radiation was made. This story, told in Power for September 11, will be of interest to all who transmit steam about their plants for any purpose.

How the Operating Engineer Can Stop Waste

A Suggested Plan for Systematically Surveying Plant Conditions

By David Moffat Myers
Consulting Engineer, New York City

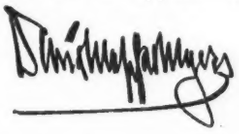
WE ALL know that operation is not the whole story of results. If the equipment is fixed and unchangeable, then and then only the results or efficiency are governed entirely by the quality of operation. The over-all result, or efficiency, is always the product of equipment times operation. Operation resolves into the human factor and equipment into the mechanical factor. We are confined in this treatment to the former. The question then becomes, "What can an engineer do with a given plant equipment."

The accomplishment of engineers and engineering bodies during the coal shortage of the War, when new power equipment was practically unobtainable in most plants, is a good answer to this question. Existing power and steam apparatus, by virtue of an inspired human-engineer-factor, was made to produce more steam and electrical units per ton of fuel to the tune of a 25 million ton saving.

Power engineers are constantly engaged in the intensive study and practice of some of the numerous phases of more or less involved technique entering as factors into the over-all economy of their plants. They tend to become specialists within a specialty, and this close concentration may cause them at times to overlook some outstanding opportunity for saving in other directions.

So what I think we all need as much as detailed scientific knowledge, is to obtain a perspective view of our job. Get far enough away from it to see the thing as a whole.

The Editor has asked me to write an article under the above title for this special issue of "Power," to appear at the time of The National Association of Power Engineers Convention. I hesitated to accept his invitation on the grounds that for me to attempt to advise a body of engineers so skilled in the art of economical operation would be exactly like bringing coals to Newcastle. He replied that there were some young members coming along who might still extract a few B.t.u.s from my coals! That was an appealing suggestion, and in addition to that, what are a few tons of coal between friends anyway! For I am happy in the feeling that both "Power" and this association are indeed old friends. So I will preach a very brief sermon on the good old gospel of conservation as applied to operation.



For this reason I shall simply present a suggestion index to assist in securing such a bird's-eye view as we all need. This index may seem very simple and elementary, and perhaps it is. But the chain of associated ideas which it is capable of starting, when combined with the technical skill of the reader, may readily result in large operating savings in more plants than one.

Read the index. Pause at each item. Sit back in your chair and let your mind dwell on the suggested idea with your own plant as a background. Other ideas associated with the first will automatically present themselves.

Go through the entire index in this manner and you will have made a questionnaire for your own plant which can be used as the logical outline of a comprehensive survey. After this is done, you may elect either one of two courses: Make a complete survey of your possibilities, or concentrate your further analysis upon one or more of the most outstanding opportunities for improvement.

Now let us take an example of ideas which naturally associate themselves when item 1 under Steam Generation is taken as a starting point. 1. "Lack of instruments for determining the performance and efficiency of boilers and furnaces." (*a*) Suitable recording instruments would have proved to the management the saving I made due to a change in operating methods. (*b*) The firemen are slipping back since they cannot see the results of their efforts. (*c*) Knowing the results would permit properly rewarding the good men and stopping labor turnover. (*d*) Labor of men and steaming of boilers are erratic—some are over- and some underloaded. (*e*) All could be corrected if the cost of instruments was not too high. (*f*) The cost includes installation, and maintenance must be considered. (*g*) How much would they cost? (*h*) This depends on the best kind and number to meet our conditions. (Note: to study this separately, and develop the simplest and least expensive plan for maximum results). (*i*) Compare dollars of cost against dollars of saving. (*j*) Fuel in dollars

SUGGESTION INDEX

Steam Generation

1. Lack of instruments for determining the performance of boilers and furnaces. Suitable instruments are the eyes of a plant without which its management is blind. If you do not know your results, then they are poor.

2. Ill-advised choice of fuel based on suitability for equipment. Kind, quality and cost. A thorough study of this matter alone will often save 10 to 25 per cent of the fuel bill.

3. Too much air admitted to the fire for combustion requirements, causing excessive chimney loss.

4. Draft control methods and equipment.

5. Inefficient firing methods or bad control of fuel and air supply. This is often due to lack of training of operatives plus lack of incentive.

6. Ash-pit losses; their causes and control. Quality of coal, fusibility of ash, rate of firing, effect of radiating surfaces of furnace on the production of clinker.

7. Unequal loading of boilers—some overloaded, some underloaded. Operating too many boilers below the best rating for economy. Methods for control of this situation.

8. Leaky brickwork in boiler setting, admitting excess air to chill the boiler, due to lack of suitable air-tight coating and bad repair of brickwork. This is a common source of waste.

9. Dirty boilers. Scale inside and soot outside of heating surface. The former may be due to lack of suitable feed water or improper treatment of feed water. The latter is due to lack of care or lack of soot-blowing equipment.

10. Baffles out of repair, allowing short-circuiting of combustion gases and raising the flue temperature.

11. Insufficient combustion space.

12. Underheated feed water.

13. Coal and ash handling. Consider its cost and the possible savings, the latter not only in actual labor measured in dollars, but also the effect of better working conditions and consequent improved labor turnover.

14. Leaks in bottom blowoff piping. A recording thermometer with bulb in blowoff main is a good tell-tale. It also checks the number of blowdowns per day and time by clock. Leaks in steam lines. Waste and danger. Leaks in feed water piping.

Distribution and Use of Steam and Energy

1. Lack of suitable electrical records for checking results. Total energy. Average load and maximum demand—daily, monthly and yearly requirements.

2. Lack of records and information on water rates of existing power units.

3. Waste of exhaust steam that could be used to replace direct boiler steam for heating or process purposes.

4. Analysis of quantity and pressures of steam required. Plot power loads over process and heating steam loads to show coincidence and develop possibilities for further utilization of exhaust steam at different pressures.

5. Check waste due to making more exhaust steam than can be used at certain periods. Analyze for methods of correction. Consider the economics of heat balance by use of purchased power.

6. Study the possibility of byproduct power from direct boiler steam now used in heating or process by first passing this steam through engines or turbines.

7. Possibility of changing a power unit from condensing operation to noncondensing when its exhaust could be used. The effect of seasonal and hourly variation on practicability.

8. Power units and auxiliaries in bad repair with leaky valves and pistons. Also check the setting of engine valves with an indicator.

9. Underloaded power units and poor load distribution. Study for improvement.

10. In cases where power is both generated and purchased, consider the effect of total cost of current by operating the power units to carry peak loads, thus reducing the maximum demand on the purchased power.

11. Electric motors throughout the factory too large for the loads, causing inefficient use of current.

12. Low power factor, causing overloading of generators and distributing system. Consider synchronous motors, static condensers and motor rearrangement as corrective measures.

13. In cases where part of the power is purchased and the balance generated, check accurately the effect of carrying more or less power on the generators.

14. Check waste of live steam through failure to shut off the supply on mains when not required. Waste through inefficient high-pressure traps. Waste through improper insulation of steam piping. Common causes of low-pressure steam waste due to bad condition of vacuum return valves.

15. Are you overheating the buildings a good part of the time? A cause of enormous waste where live steam is used without proper control. Improper control includes opening of windows over hot radiators.

16. Are your indirect heating systems equipped with return air ducts, or is all the air drawn from an arctic outside atmosphere?

17. Are all hot drips conserved and returned to boilers or elsewhere efficiently utilized?

18. Waste of electrical energy or steam due to a surplus of water pumped and then wasted; or air compressed and then wasted through leakage.

19. Cost of oil and supplies. Is your lubrication system up to date?

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and labor in dollars. (*k*) Under fuel bring information up to date on predicted savings. (*l*) Under labor, by better load distribution ascertain the possibility of fewer boilers needing less firing labor. (*m*) Labor for upkeep of instruments. How to care for them systematically. (*n*) System—Records of the simplest and most informative sort. These must harmonize with instruments decided upon. (*o*) Instruments—CO_2, steam flow, air flow, draft, flue temperature, feed-water meters, coal meters. (*p*) Coal saving—immediate perhaps by airtight coating on boiler walls. (*q*) Other places of possible air infiltration. (*r*) Why not test with candle or use smoke test? (*s*) Tests on other phases of plant operation outside of boiler room reminds me I had better survey all departments and possibilities before deciding where the greatest saving for the least money can be made. Then tackle that first.

This was my personal reaction to a leisurely concentration on item 1 of the Index. Your chain of associated ideas will take a different order. There is an infinite variety in the connecting links of the chain, but each type of mind will gather in the whole chain in its individual way if concentration on the subject is sufficiently prolonged.

The index simply supplies logical starting points for your analysis, and you may develop a better one of your own. But mine is set down here for whatever assistance it may be.

Equipment Suiting Plant Conditions

Aids Waste Elimination

By F. M. Gibson

Plant Engineer, American Sugar Refining Co., New York City

IT IS possible to overstress the importance of reducing the cost of industrial power for the reason that many industrial plants are suffering from a power that is already too cheap. Many writers, in considering this subject, discuss the reduction in cost per 1,000 lb. of steam, per horsepower, or per kilowatt. A greater number of plants can be compared by this standard than by any other. It is constructive and not to be deprecated. Nevertheless, it is not a complete discussion and is likely to draw attention from the real cost of power in its final analysis. Power is a service commodity, and its value should be measured by its effect upon the production of manufactured goods and not solely upon its basic cost.

Most industries make their profit by their ability to take advantage of favorable and oftentimes sudden changes in market conditions. This necessitates sudden increase in the production of the plant as a whole or in one particular quality of product, or, when one plant manufactures several articles, in one particular article. To provide reasonable excess capacity in power equipment, continuity of service and flexibility in balancing power and heating loads that will meet the requirements of these production programs means a greater investment in equipment for generating, transmitting and applying power and its allied services. If that investment is curtailed, the basic price of heat and power may be lower; but it will be too cheap because it will interfere with profit-making production.

Designing engineers sometimes endeavor too earnestly to develop a plant with a low cost of installed horsepower or a low figure of installed horsepower per unit of production. Their desire in this direction leads to a minimizing of the importance of power demand under abnormal operating conditions. To illustrate this in a small way, the recent experience of a chemical plant may be cited. One department in that plant consisted of machines of intermittent operations, started loaded, and discharging after a period of operation. The starting torque was very high. Some of these machines were grouped in sets of four and some in sets of three. The sets of four were equipped with a 125-hp motor and the sets of three with a 100-hp. motor. Under usual operating conditions there would be two machines in the sets of four that would start at one time, and the 125-hp. motor was capable of carrying the double starting torque. Under ordinary conditions the starting of two machines at the same time in the sets of three would not occur.

Occasionally, this department would have interruptions and it would be necessary to speed up production in order not to interfere seriously with other departments. Under such conditions the cycle of operation was shortened and two machines of the sets of three would start at one time. The motors were equipped with fuses instead of circuit breakers, and when two machines started simultaneously, fuses were blown because the 100-hp motor would not stand the doubled starting torque. Before the machines could be started again, it was necessary to unload them and send the material back to an earlier department to be reprocessed.

Efforts to induce the operatives to use more discretion in starting the machines were not successful and the supply of fuses became low, until some one had the bright idea of replacing the fuses with copper jumpers. Then the motor burned out. The production of this department fell below normal and the production of the entire plant was adversely affected. This plant enjoyed the reputation of a low figure of installed horsepower per ton of product. It was cheap power, but when measured by service to production it was very expensive.

Industrial plants as a rule are constantly changing even when new. New manufacturing equipment, new processes, automatic machinery and labor-saving equipment are constantly being added. This results in increased demand for power, heat, compressed air, refrigeration and other service commodities. It is in making these additions that the cost of heat and power suffers most. In order to reduce the cost of installation, the new lines are tied into the system at the nearest available point. It is not a question of tying in where friction losses will be

most economical, but a question of the nearest point where the lines will stand it. One engineer tells of adding equipment using large quantities of compressed air—in fact, so much air that, according to his figures, new lines from the air compressors would yield 20 per cent annual returns on the cost of the new piping system. It was necessary to add the cost of the new piping system to the cost of installation of the manufacturing equipment, and it appeared as reducing the savings to be effected by the new equipment. This was not pleasing to the sponsors of the new equipment, so the installation was made without the new air lines. The engineer was promised that a new air line could be installed later. That was five years ago, and although the engineer has tried several times to secure an appropriation for the purpose, the change has never been made.

In another instance electric cables ran from the second floor of building A into the second floor of building B, then to the eighth floor of building B, across to the eighth floor of building A and thence to the fourth floor of building A. Owing to changes over a period of a few years, the occupancy of building B was so changed that there was but one 5-hp. motor in the building, on the eighth floor, and on the fourth floor of building A there was 600 installed motor horsepower. The line was overloaded and the drop in voltage was excessive, still it existed for four years before it occurred to anyone that it should be changed.

It is in this manner that transmission systems for water, steam, electricity and air multiply until the plant is honeycombed with overloaded and over-long lines. To correct the condition means installing a complete new system of piping or wiring, which to many plants is a large expenditure. In many old plants it is felt that the expense cannot be afforded, and they are forced to continue with an excess cost of power per unit of production. It is this continual practice of obtaining additional power at low installation cost and failure to readjust lines as changes occur in the plant that has ruined one industrial plant. Also one occasionally hears of plants installing new generating equipment before correcting losses outside of the generating station. In one case the outside losses were corrected after the new generating station had been installed and it was discovered that, if the losses had been corrected first, the generating station capacity could have been reduced 30 per cent.

Many instances might be related of engineers who make their calculations by rule of thumb (usually the wrong thumb) and of the overly cautious engineers who overestimate their requirements. For example, one engineer had charge of installing centrifugal pumps for water supply. The amount of water required was metered so that the pump had the proper capacity of about 6,500 g.p.m. Two pumps were installed, one as a spare, and were run at constant speed. The discharge pressure normally ranged from 46 to 57 lb. per sq.in., depending upon the quantity used. In the course of time the demand for water rose to 8,500 g.p.m., so that two pumps had to be used. Much to his surprise the discharge pressure rose to 73 lb. His chief concern had been to secure pumps with sufficient head. There was a rather long run of pipe whose friction loss was overestimated and a liberal allowance added for safety's sake. The consequence was that the maximum head for which the pump was designed was nearly double that required, and a good part of the time he was wasting a large amount of power. The most frequently noticed inefficient expenditures of heat and power are in heating and ventilation. The fault is either in excessive equipment giving uneven conditions in the space served or the expenditure of heat and power for inadequate service. Radiation is frequently found placed where supply and return lines will be shortest and of least expense rather than at the most effective location. It can be found on the ceiling or on the inner walls of a room, so that the inner section of the room is very warm and the section near the exposed wall is almost cold. Adding radiation surface instead of closing up leaky doors and windows is often done.

F. M. GIBSON *says:*

"Power is a service commodity and its value should be measured by its effect upon the production of manufactured goods and not solely upon its basic cost. . . . If investment [in power equipment] is curtailed, the basic price of heat and power may be lower; but it will be too cheap because it will interfere with profit making production."

Installing fans to cool a hot room instead of insulating hot pipe lines, tanks and other equipment is not uncommon. Consideration is not given to the fact that insulation does not require the power and maintenance that fans do or that the loss of heat from hot surfaces is an unnecessary expense. Fans are often placed in walls to blow outside cool air into the room, and usually there is a liberal clearance between the tips of the fan blades and the opening in the housing or wall opening. Hot air from the room will flow out through this clearance space, get caught in the current and enter the room again through the center of the fan. Oftentimes, these large fans send the air but a short distance across the room, not only failing to send the cool air to even the center of the room, but also holding the heated air in a pocket on the far side of the room. A system of air ducts from the fan to various parts of the room not only accomplishes more, but frequently will do it with one-half of the power.

Even when ducts are used, the outlets are sometimes placed without judgment. A New York plant had a room filled with ovens under a slight air pressure, so that the heated air was blown through loose-fitting doors into the room, making it so hot that there was a large labor turnover. A fan-and-duct system was installed with the outlets on the ceiling directly in front of each oven and in the spot where the operator stood. The hot air from the ovens rose to the ceiling and was thrown down by the current of fresh air. The conditions were slightly

improved, but there was still a large labor turnover. After further consideration the outlets were placed on the wall opposite the oven door and a few feet above the floor, so that the fresh air reached the operative, continued on to the ovens, keeping the hot air close to the oven front and deflecting upward. The conditions were much improved and there was a sharp decline in turnover. Perhaps it may occur some day to this company to place the ovens under a slight draft instead of pressure and to equip the ovens with close-fitting doors.

The attitude of a certain class of plant engineers is a stumbling block to improvements and reduced costs. This class of engineers is largely comprised of the type that is so busy with maintaining operations that there is no time to bother with equipment that doesn't work. It is a case of "either it works or goes out." This is the type who permits a manufacturer to install equipment under a guarantee and then dares him to make good. There are many times that equipment fails to meet guarantees owing to the fact that conditions are not as the plant engineer has represented them or to some condition not fully appreciated by the manufacturer. Usually, a little assistance from the engineer will eradicate the trouble. If the equipment will effect a reasonable saving, it is just as important to the engineer that it should be a success as it is to the manufacturer. For that reason the engineer should endeavor to aid the manufacturer in every way possible.

A plant engineer recently stated to a group of engineers that a certain manufacturer had tried to install automatic control over a series of operations, but had to take out the equipment because he could not meet his guarantees. Upon being questioned, it developed that under certain conditions of short duration a slight vacuum was created in one chamber and the equipment did not function perfectly under that condition. After further thought it was admitted that the equipment, if allowed to remain, would have accomplished 90 per cent of the anticipated savings of perfect control and that the cost of installation would have been saved in ten months. Later on, the engineer mentioned a small alteration that he thought would have corrected the fault.

In contrast with this engineer was another in the group, who related that, against strong opposition from the manufacturing department, he had succeeded in reducing heat consumption by reducing the temperature of one process by 70 deg. F. He valued the maintenance of operation as highly as the first engineer and above that he had the urge to cut costs by careful study of conditions.

One great hindrance to the reduction of power and heat costs, according to the viewpoint of many plant engineers, is the reluctance of the management to grant money for improvements of an engineering nature. One of the reasons for this is that the plant engineer lacks salesmanship. Oftentimes his proposals are neither clearly nor convincingly stated and, forgetting that what is obvious to an engineer may not be so obvious to others, he only indicates some things that should be explained. Also, he is prone to use general statements to support his arguments when he should give substantiating facts and figures.

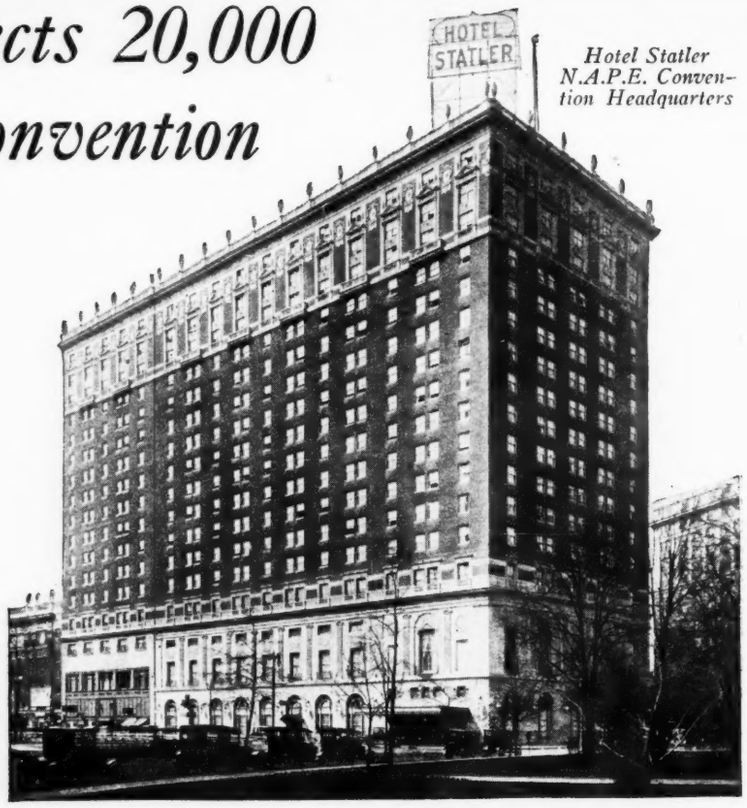
Some engineers feel that because the manager has reached his position through the production department, he can make decision concerning proposals from that department upon his past experience, while on engineering proposals he must reluctantly depend upon the judgment of others. Another reason is that many faulty conditions are not offensive to the eye or ear. They make no disturbing noises nor unsightly mess upon the floor. It is what Mr. Low has termed "silent inefficiency." It is not so obvious as some other conditions and can therefore be postponed to a later date.

The subject is too broad and the article is too short to discuss other methods of reducing costs, such as higher steam pressures, reduction of exhaust steam, salvage of heat from waste gases and waters, greater uses of exhaust steam in place of live steam and many other important items. It is not the intent of this article to show by technical discussion or mathematical formulas how the cost of power may be reduced, but to indicate why such reductions are not made. The reasons are the lack of judgment, consideration and co-operation on the part of the designing engineer, the plant engineer and the management. When these faults have been corrected, the major part of waste power and heat in industry will be eliminated. The effort has been made to present the viewpoint of the plant engineer on the subject as obtained by frequent intercourse with plant engineers in various industries. It is not the intention to imply that all industrial plants are suffering from excessive power costs. While grossly inefficient plants are frequently discussed, it must be remembered that one hears little of the many well-designed plants intelligently operated under sympathetic management.

Why Engineers Sometimes Fail to Get Money for Improvements

"One great hindrance to the reduction of power and heat costs, according to the viewpoint of many plant engineers, is the reluctance of the management to grant money for improvements of an engineering nature. One of the reasons for this is that the plant engineer lacks salesmanship. Oftentimes his proposals are neither clearly nor convincingly stated, and, forgetting that what is obvious to an engineer may not be so obvious to others, he only indicates some things that should be explained. Also, he is prone to use general statements to support his arguments when he should give facts and figures."

N.A.P.E. Expects 20,000 At Detroit Convention



Hotel Statler N.A.P.E. Convention Headquarters

FOR the forty-sixth annual convention of the National Association of Power Engineers, to be held in Detroit from Sept. 10 to 15, inclusive, comprehensive plans have been made for one of the largest and most successful gatherings ever held by this organization. Throughout the five-day program education will be brought prominently to the front. Every session will have a nationally known speaker, such men as Alex Dow, Henry Ford, W. B. Mayo, Thomas E. Black and F. H. Moorehead participating.

On the second evening of the convention a full technical session will be held. There will be entertainment, plenty of it, inspection trips and full opportunity to view the largest power and mechanical exhibition ever fostered by the association. This will be housed in "Convention Hall," Detroit's convention headquarters and America's largest exposition hall.

Headquarters for the convention will be at the Statler Hotel. The committee responsible for the convention is as follows: Garrett Burgess, chairman; Wm. W. Dulmage, vice-chairman; T. A. McLucas, secretary; M. C. Schwenk, treasurer; A. H. Betwee, John Bohnsack, H. D. Butterfield, A. F. Carter, N. K. Chamberlin, C. F. Clark, James Cleary, Frank Gladish, John Gretzinger, Thomas O. Hadden, M. F. Harrington, L. H. McCracken, Joe Moon, L. A. Pierson, Barney Platt, C. A. Remley, L. J. Schrenk, E. A. Sitter, F. T. Sleeth, W. G. Webster, Alex. Werner.

The program in detail follows:

Monday, September 10

9 a.m. to 9 p.m.—Registration, Statler.

7 p.m.—Official opening of the Detroit National Power and Mechanical Exhibition, Convention Hall, by Garrett Burgess, General Chairman, Convention Committee. Address by Mr. Jacob Eige, President, National Exhibitors' Association. Response by Mr. Elmer L. Bassett, National President, N.A.P.E.

8 p.m.—Concert in Convention Hall.

Tuesday, September 11

9 a.m. to 9 p.m.—Registration, Hotel Statler. No registration after this date.

10 a.m.—New Masonic Temple, Consistory Cathedral—Invocation by Rev. Arno H. Wallschlaeger. Organ Recital. Master of Ceremonies, Garrett Burgess, General Chairman, Convention Committee, introducing His Excellency, Fred W. Green, Governor of the State of Michigan, who will deliver an address of welcome on behalf of the Commonwealth of Michigan. Response by Elmer L. Bassett, National President, N.A.P.E. Henry Ford. Response by Edward Jacques, Past National President, N.A.P.E. Hon. J. C. Lodge, Mayor, City of Detroit. Response by Thomas R. Herlihy, National Vice-President, N.A.P.E. Harvey Campbell, of the Detroit Board of Commerce. Response by Fred W. Raven, National Secretary, N.A.P.E. Official opening by President Bassett. Appointment of committees.

12 noon—Official photograph on ground of New Masonic Temple.

12:30 p.m.—Luncheon in New Masonic Temple.

1:30 p.m.—Inspection of New Masonic Temple.

2:30 p.m.—Convention Hall—Convention called to order. Business session. Report of credentials committee. Report of officers. Report of national committees.

4 p.m.—Address by Wm. B. Mayo, Chief Eng., Ford Motor Co., on aeronautics.

8 p.m.—Life and Accident Department meeting. Industrial Safety Council meeting.

7:30 p.m.—Masonic Temple Orchestra.

Wednesday, September 12

8:30 a.m.—Assemble at Hotel Statler for tour of inspection of Fordson Plant of the Ford Motor Company and Ford airport.

2:30 p.m.—Second business session. Reports of various committees. Final report of credentials committee. Roll call. Address by Mr. Thomas E. H. Black.

4 p.m.—Address by Mr. H. D. Savage, President, Combustion Engineering Corp.

9 p.m.—Entertainment by National Exhibitors' Association.

Thursday, September 13

9:30 a.m.—Reports of various committees. General discussion.

11 a.m.—Address by Alex Dow, President, Detroit Edison Company.

11:45 a.m.—Official visit of Ladies' Auxiliary.

12:15 p.m.—Annual memorial services.

2:30 p.m.—Reports of committees.

4 p.m.—Address by Mr. F. H. Morehead, Chief Engineer, Walworth Company.

9:30 p.m.—Grand Ball, Commandery Ball Room, New Masonic Temple. Band Concert in Commandery Ball Room Gardens.

Friday, September 14

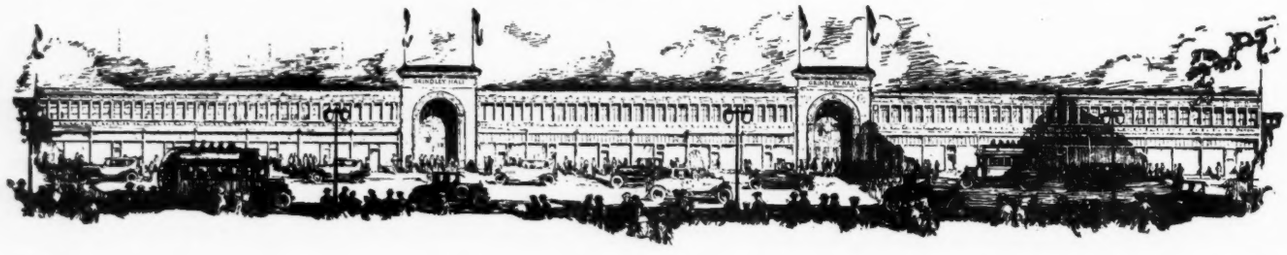
9:30 a.m.—Final business session. Election of officers. Selection of 1929 convention city.

8:30 p.m.—Public installation of officers, convention hall. Entertainment.

Saturday, September 15

10 a.m.—Lake ride or sight-seeing tour of Detroit.

Convention Hall Covers Five Acres



Exhibitors at Convention Hall

Company	Booth No.
Aerologist Publishing Co.	435
Alexander Bros., Inc.	258
Allis-Chalmers Mfg. Co.	59/60
Allpax Company, Inc., The	104
American Injector Co.	155
Amer. Pipe Bend. Mach. Co.	367
American Temp. Ind. Co.	377
Allen Bradley Co.	146/7
Anchor Packing Co.	110
Anthracite Coal Service Co.	310
Armstrong Machine Works	114
Ashton Valve Company, The	336
Automatic Electric, Inc.	171
Baker Raulang Co.	31
Baker Valve Co.	323
Baldwin Chain & Mfg. Co.	99
Bartlett-Hayward Co.	65
Berco Coal Co.	344
Berry Brothers, Inc.	417
Bernitz Furnace Appliance Co.	345
Bethlehem Steel Co.	357/8
Bigelow-Liptak Corp.	291
Blaw-Knox Co.	160/1
Bowser & Co., Inc., S. F.	318
Boyer-Campbell Co.	284/5
Bristol Company, The	277
Brooks Oil Co., The	272
Brown Instrument Co.	116
Brownell Co.	385/6
Buckeye Blower Co.	416
Bull Dog Electric Products Co.	130/1
Burroughs Add. Machine Co.	164
Bussman Mfg. Co.	320
Butterfield, H. D.	25
Cadillac Electric Supply Co.	81
Cais Co., T. J.	159/283
Carbon Engineering Corpn.	312
Chapman Valve Mfg. Co.	308
Chicago Faucet Co.	309
Chicago-Jefferson Fuse & Elec. Co.	371
Cleveland Worm & Gear Co.	175
Clipper Belt Lacer Co.	266
Coats Machine Tool Co., Inc.	372
Cokal Stoker Corp.	123
Collord & Co., H. T.	366
Colt's Pat. Firearms Mfg. Co.	256
Combination Pump Valve Co.	233
Combustion Engineering Corp.	165/6/7/8/9
Connelly Boiler Co., The D.	376
Connery & Co.	34/5/6
Continental Motors Corp.	102
Coon De Visser Co., The	177/8/201/2
Corin, Thos. C.	63
Crandall Packing Co.	321
Crane Co.	288/9
Crane Packing Co.	349
Cutler-Hammer Mfg. Co., The	127/8
Dearborn Chemical Co.	324/5
Degan Co., James E.	152/3/4
Detrick Co., M. H.	66
Detroit City Gas Co.	412
Detroit Edison Co.	61/2
Detroit Graphite Co.	172
Detroit Hoist & Machine Co.	420
Detroit Ice Machine Co.	23
Detroit Oak Belting Co.	389
Detroit Rohpac Products Co.	16
Detroit Seamless St. Tube Co.	173/4
Detroit Steel Casting Co.	170
Detroit Stoker Co.	422/3
Diamond Power Specialty Co.	319
Dixon Crucible Co., Joseph	322
Dri Steam Valve Corp.	103
Durametallic Corp.	74
Economic Engineering Co.	27
Economy Pumping Mach. Co.	293
Edison Storage Battery Co.	32
Edwards, H. D., & Co.	234
Electric Machinery Mfg. Co.	419
Elliott Co.	279
Elwell Parker Electric Co.	268
Evans Elevator Equalizer Co.	73
Everlasting Valve Co.	278
Fairbanks, Morse & Co.	82
Falk Corporation, The	365
Farnsworth Co.	410
Finnell System, Inc.	20
Fisher Governor Co., The	287
Flexible Steel Lacing Co.	251
Ford Motor Co.	179/200
Foster Engineering Co.	262
Foxboro Co., The	18/19
France Packing Co.	249
Fuel Oil Corporation	229
G&M Industrial Eq'pm't Co.	315/16
Garlock Packing Co.	330
Garratt-Callahan Co.	328
General Electric Co.	302
Gordon, J. A.	333
Green Fire Brick Co., A. P.	295
Greene, Tweed & Co.	326
Grinder Sales Co., The	122
Hagan Corporation	119
Harbison-Walker Refract. Co.	67
Hardinge Co., Inc.	117
Harvey & Sons Mfg. Co., A.	375
Hawk-Eye Compound Co.	370
Hawley, G. J.	351
Hays Corporation, The	118
Heat Sealing Kant Burn Co.	163
Hoffman Specialty Co., Inc.	392
Hollow Center Packing Co.	17
Home Rubber Co.	113
Homestead Valve Mfg. Co.	257
Hopkins Electric Co., H. M.	236
Hurley, John T.	22
Illinois Engineering Co.	198
Industrial Controller Co.	120
International Corresp. Schools	157
Invincible Vac. Cleaner Co.	263
Ironton Firebrick Co.	156
I. T. E. Circuit Breaker Co.	129
Jenkins Bros.	331/2
Johns-Manville Corp.	100
Johnson Manufacturing Co.	354
Kerr Machinery Corp.	141/2/3
Keystone Lubricating Co.	69/70
Kieley & Mueller, Inc.	77
King Refractories Co., Inc.	115
Korfund Co., Inc., The	57
Leeds & Northrup Co.	421
Leschen & Sons Rope Co., A.	252
Lunkenheimer Co., The	275/6
Malcomson Auto. Stoker Co.	281/2
Mason Regulator Co.	311
McConnell, D. B.	199
McDonough Coal Saving Corp.	259
McIntosh & Co., Chas.	85
McLeod & Henry Co.	162
Mechanical Heat & Cold, Inc.	230/1/2
Modine Manufacturing Co.	411/434
Mohawk Co., The	26
Morehead Mfg. Co.	68
Morse Chain Co.	88
Thomas E. Murray, Inc.	158
Michigan Mineral Felt Sales Co.	296
Middleton, D. R.	14
Murray Iron Works Co.	228
Mason Co., Frederick H.	124/5/6
National Aluminate Corp.	86
National Educational Committee	303
National Engineer	314
National Exhibitors' Ass'n	253
National Tube Co.	339/40/1/2
Neckar Water Softener Corp.	107
Nicklir & Co., E. W.	101
Northern Engineering Works.	28/9
Nash Engineering Co., The	143/4
National Elec. Products Corp.	313
Oakite Products, Inc.	317
Oil Heat Service Co., Inc.	112
Otis Elevator Co.	299
Palmer-Bee Co.	297
Peerless Machine Co.	37
Pennsylvania Pump & Compressor Co.	369/390
Permutit Co., The	290
Pittsburgh & Ohio Mining Co.	424
Plibrico Jointless Firebrick Co.	337/8
Poe Company	261
Powell Co., Wm.	254/5
Power	298
Power Plant Engineering	343
Power Plant Equipment Co.	373/4
Pyrometer Instrument Co., The	270
Plath & Fittinger Co.	408/9
Peck, Stow & Wilcox Co.	364
Quigley Furnace Specialties Co.	246/7
Randall & Co., D. T.	13
Reeves Pulley Co.	89
Refinite Co., The	301
Reliance Gauge Column Co.	76
Republic Flow Meter Co.	71/2
Riley Stoker Corporation.	378/9
Rinshed-Mason Co.	393
Roebling's Sons Co., John A.	286
Ross Heater & Mfg. Co.	292
Roto Co., The	250
Roxana Petroleum Co.	91/2
Rex Clay Products Co.	387
Sales & Co., Murray W.	108/9
Sarco Co., Inc.	38
Scheiwe Coal & Ice Co.	214
Sharples Specialty Co., The	260
Skidmore Corporation	47
Smith & Co., Young C.	356
Smith, Hinchman & Grylls.	176
Snap-On Wrench Co.	75
Square D Company	15
Squires Co., C. E.	329
Standard Fuel Engineering Co.	383/4
Standard Oil Co. (Indiana)	58
State Manufacturing Co.	350
Strong Scott Mfg. Co., The	64
Sugar Beet Products Co.	415
Sumet Corporation	87
Superheater Company, The	111
Swartwout Co., The	355
Signal Engineering & Mfg. Co.	418
Strelinger Co., Chas. A.	273/4
Siewek Tool & Die Co.	98
Spaulding Electric Co.	105
Talcott, Inc., W. O. & M. W.	413
Terry Steam Turbine Co., The	79/80
Texas Co., The	21
Trerice Co., H. O.	380/1/2
Trill Indicator Co.	121
Troy Engine & Machine Co.	57
Unishear Co., Inc., The	368
United States Rubber Co.	148/9
United States Products Corp.	271
Vacuum Oil Co.	391
Volz Engineering Corporation.	280
Wagner Electric Corporation.	294
Warren Webster & Co.	150/1
Western Waterproofing Co.	334
Westinghouse Elec. & Mfg. Co.	346/7
Wickes Boiler Co., The	348
Williams Valve Co., The D. T.	335
Wright-Austin Co.	24
X Laboratories	248

Detroit—City of Power

General Motors

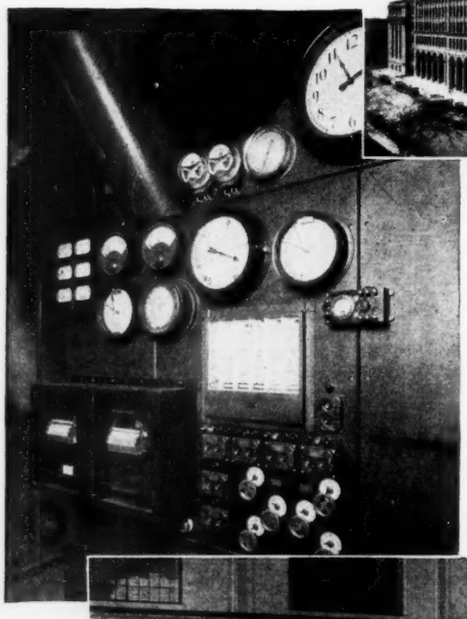
(Right)

Housing approximately 6,000 people, the General Motors building and research laboratory is the largest office building of its kind in the world. A staff of 500 is required to service the building.

Steam Generator

(Below)

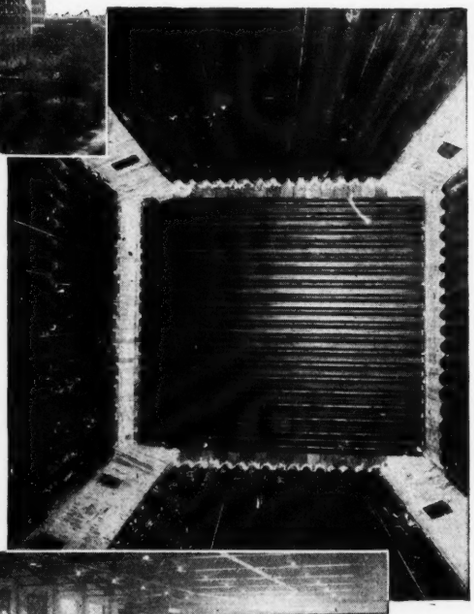
View looking up in furnace of one of the two "steam generators" installed in the Detroit Plant of the U. S. Rubber Company. This generator has delivered 150,000 lb. of steam per hour for 16 hours.

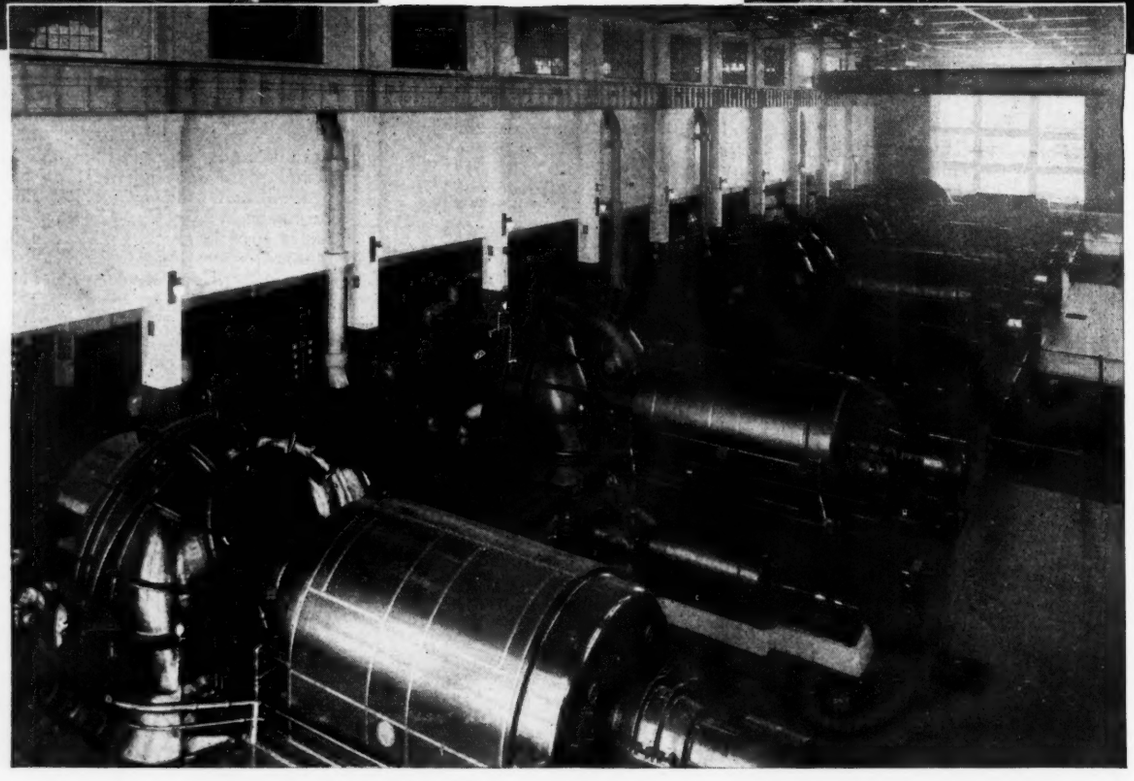


U. S. Rubber

(Left)

Control board for one of the steam generators installed in Detroit plant of the U. S. Rubber Company. The full complement of instruments for temperatures, pressures, steam and water flow, CO_2 draft, station load, and meters and control for motors are in evidence.

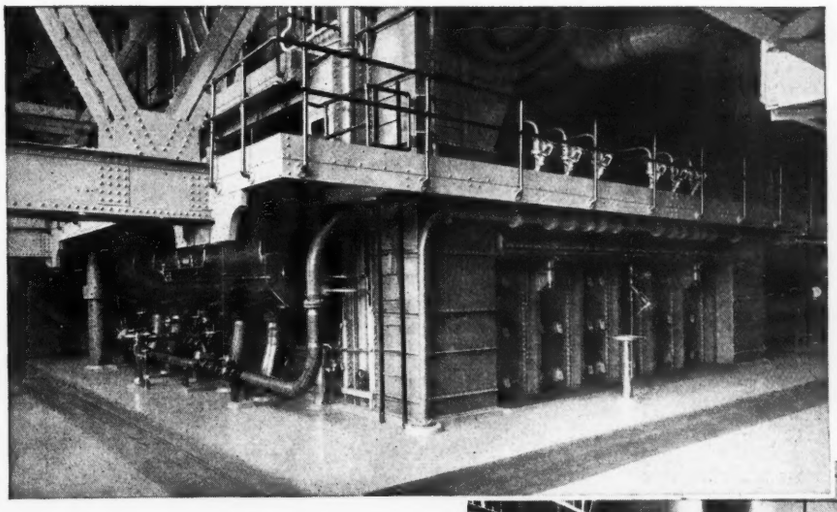




Trenton Channel Turbine Room, Detroit Edison Company

The five 50,000-kw. single-barrel General Electric turbines are of identical design, so that all major parts are interchangeable. Note large open spaces around the main units and auxiliaries. The eleven 29,100-sq.ft. boilers are fired with pulverized coal.

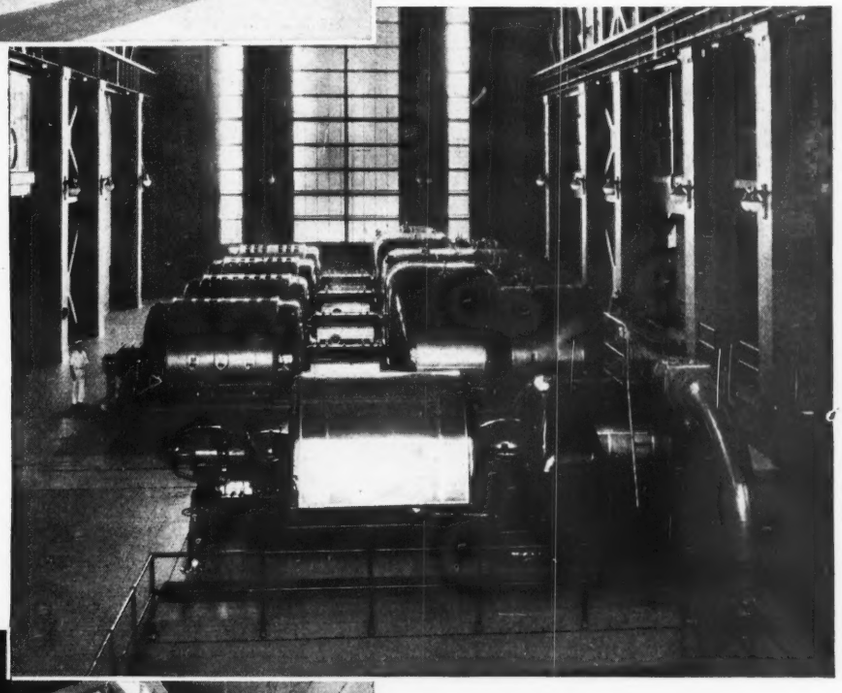
First Step in Automobile Manufacture



Fordson Boiler Room

(Left)

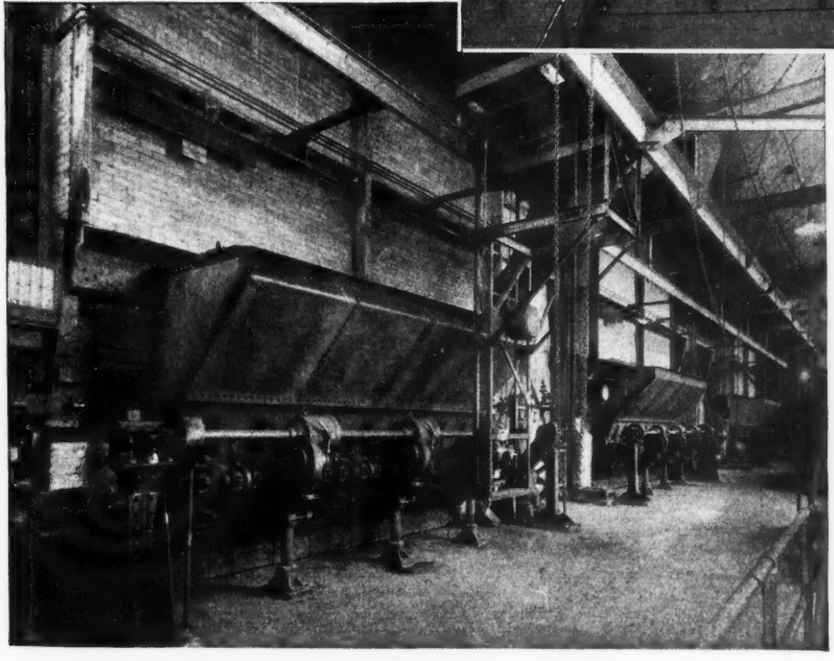
Ford power plants are the show places of the works they serve. Here is one of the eight boilers at the Fordson (formerly River Rouge) plant. Each of these boilers contained originally 26,470 sq.ft. of heating surface and was designed for the simultaneous burning of blast-furnace gas and powdered coal. With increasing demands for steam the capacity of four of these boilers was doubled by enlarging the furnaces and arranging water walls and radiant superheaters with independent circulating systems delivering into the main header. From each of these remodelled units a capacity of 500,000 lb. of steam per hour is available.



Fordson Turbine Room

(Right)

The turbine room of the Fordson plant now contains four 30,000 - kva. turbine - generators designed and built by the Ford Motor Company. When the initial 12,500-kva. units are removed, space will be available for eight more of the larger units. The condensers and their auxiliaries, exciters, and practically all equipment of the turbine room, are of Ford design and therefore of more than passing interest.

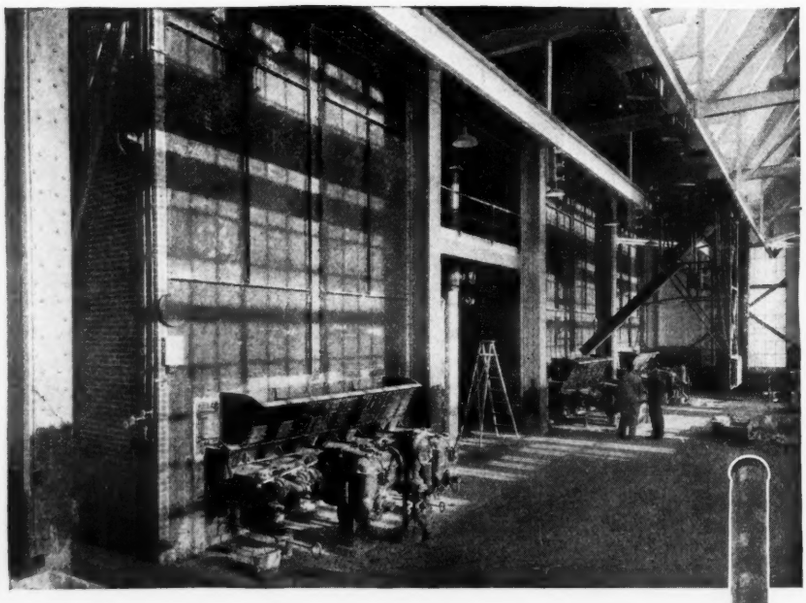


Packard Boiler Room

(Left)

The new boiler plant of the Packard Motor Car Company, designed by the Sessions Engineering Company, is ultra modern for an industrial installation and one of the first in Detroit to go under Smoot automatic control. It contains four 12,000-sq.ft. Connelly bent-tube boilers designed for 325 lb. operating pressure and 150 deg. F. superheat. Taylor 10-retort underfeed stokers, 29 tuyeres deep, serve the boilers and to them is delivered from Ljungstrom preheaters air heated to 480 deg. F. The Diamond soot blowers serving each unit operate at full boiler pressure. Among the many other things of interest in this plant is a forced-circulation, hot-water heating system operating in conjunction with a steam turbine of the extraction type.

They Generate the Steam T



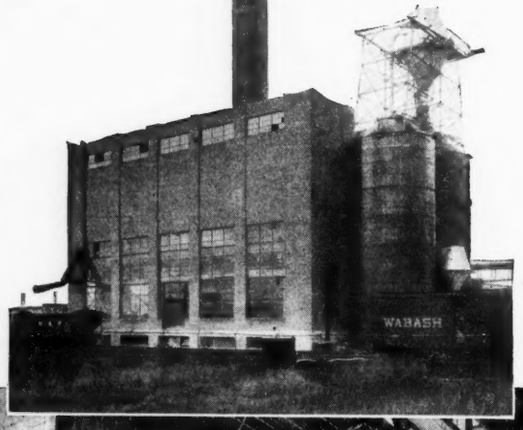
Briggs Mfg. Company

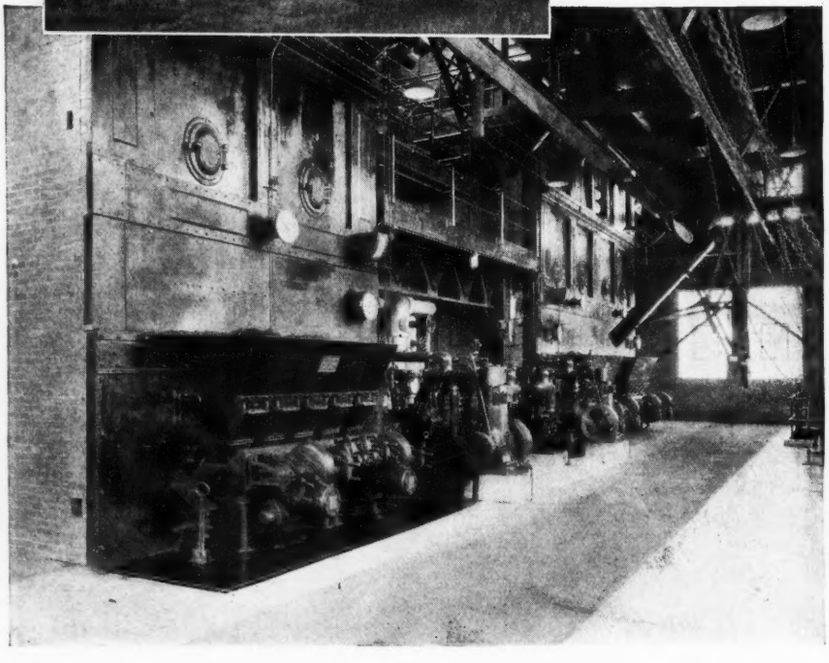
Mack Ave. plant of the Briggs Mfg. Co. contains three Heine V-type boilers, each having 7,460 sq.ft. of steam-making surface and operating at 200 lb. gage pressure. Frederick underfeed stokers serve the boilers, although much of the steam is generated by hog fuel introduced over the fuel bed on the stokers. Something new is the Terry turbine drive for the stokers. Forced draft is supplied by turbine- and motor-driven fans.

Briggs Mfg. Company

(Right)

An exterior of the Briggs boiler and compressor plant, showing the self-supporting steel stack, lined to the top, and the hog-fuel cyclone and storage tanks at the right.

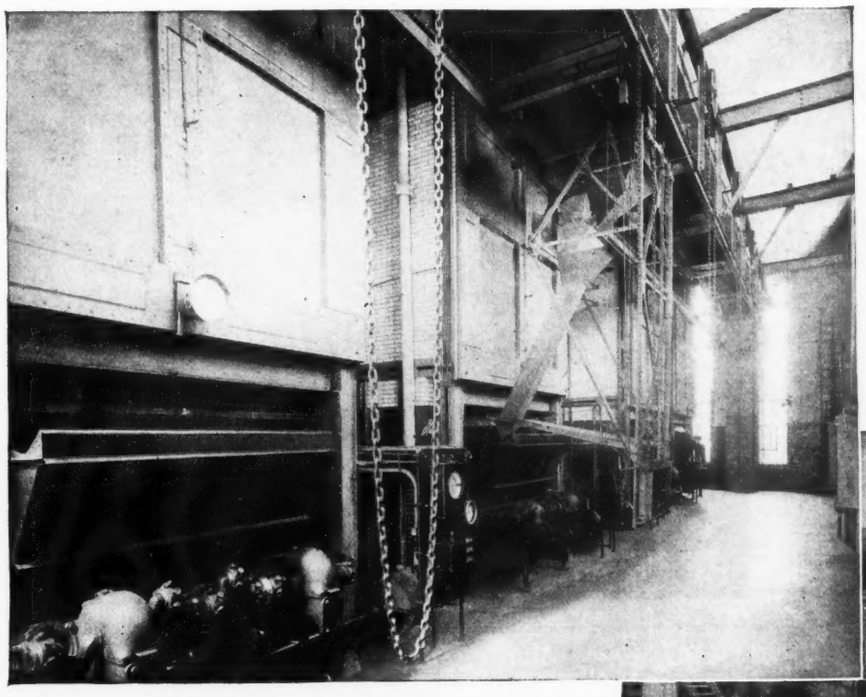




Herman Kiefer Hospital

Boiler room of the Herman Kiefer Hospital for contagious diseases. Because of the location coal must be delivered in trucks and ashes carted away. Notwithstanding, this may be considered an ideal isolated plant supplying the various services common to a group of hospital buildings. The plant, which is neatly arranged and modern, is of Albert Kahn design and contains three 3,890-sq.ft. Stirling boilers served by Detroit five-retort underfeed stokers, driven by Engberg engines.

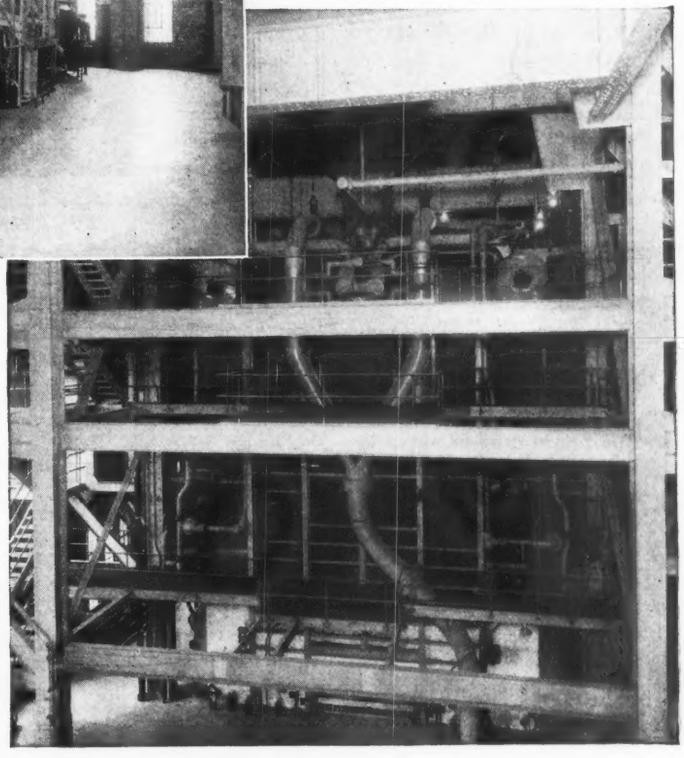
am That Keeps Detroit Moving



Boulevard Plant

(Left)

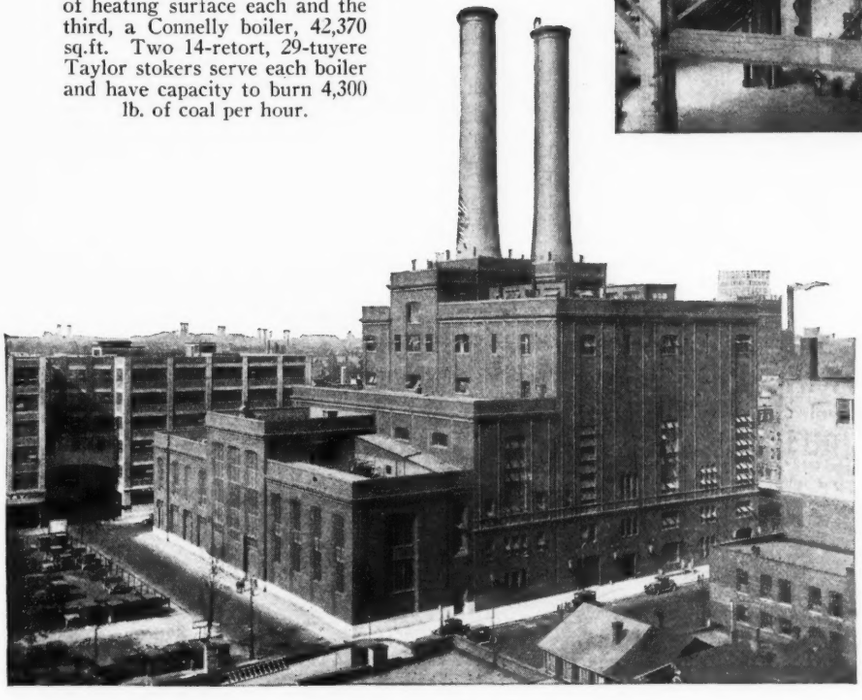
Formerly owned and operated by the General Motors Building, this boiler room is now the Boulevard Heating Plant of the Detroit Edison Company, serving with steam the entire district around Woodward Ave., including the General Motors Building and the new Fisher Building. It is regarded as one of the show plants of the city. Four 5,000-sq.ft. boilers in independent settings are served by motor-driven underfeed stokers.



Beacon Street Plant

(Below)

The Beacon Street Heating Plant of the Detroit Edison Company contains three of the largest boilers in the world, speaking from the viewpoint of steam-making surface but not capacity. Two of these boilers (B. & W. Type W) contain 41,550 sq.ft. of heating surface each and the third, a Connelly boiler, 42,370 sq.ft. Two 14-retort, 29-tuyere Taylor stokers serve each boiler and have capacity to burn 4,300 lb. of coal per hour.

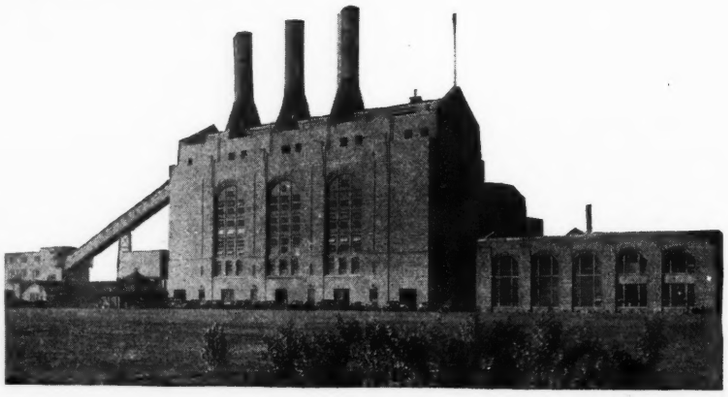


Beacon Street Plant

(Above)

This is a side view of one of the boilers in the Beacon Street Heating Plant of the Detroit Edison Company, and indicates the enormous size of the installation. At the center are the two steam outlets joining by a "Y" fitting to the steam main leading underground. An added attraction in this plant is the by-product generation of electricity by means of variable back-pressure turbines.

What is in Detroit's
MORRELL STREET PLANT
—and what it Cost



DETROIT now has a municipal power plant of adequate size to meet the rapidly growing demands of the various departments of this important industrial city. The plant is operated by the Public Lighting Commission under a provision of the charter which requires energy to be furnished at cost.

Prior to the construction of the plant three smaller plants were operated by the city. One was under the jurisdiction of the Public Lighting Commission and furnished energy for street lighting and the lighting of public buildings. The other two were operated by the Department of Street Railways solely for street railway purposes. The new plant furnishes energy for both of these city departments and in addition takes care of sewage pumping, water-works, fire department and other miscellaneous requirements.

Much thought and time were given to the selection of a site, the chief factors influencing the location being coal supply and storage, condensing water and realty values. The site chosen at the foot of Morrell Street on the Detroit River combines to an unusual degree all these desirable features. There are excellent railroad facilities and available water, and coal can be delivered by barge at a considerable saving. The plant has an unlimited supply of clean condensing water, the temperature of which rarely exceeds 75 deg. F. The site chosen is of sufficient size for an ultimate capacity of 120,000 kw., with ample coal-storage facilities.

The plant is arranged in units, each functioning as a separate power plant in itself. The site has been developed for the ultimate capacity. The power house has been built for four units and equipment for three has been installed, also a part of that for the fourth unit in the case of some apparatus. One plant unit consists of one 25,000 kva. turbine-generator with condenser, boiler-feed pumps, two boilers, transformer and electrical equipment.

Coal is received by water primarily and by rail secondarily and is delivered either to storage or to the green-coal bunkers. From the green-coal bunkers it passes by gravity through the driers to the pulverizers, from which it is discharged through the cyclone collectors to the

Summary of Costs

		60,000 Kw.	80,000 Kw. (Additional Cost)
SITE DEVELOPMENT			
1. Yards, grading, etc.	$10,875.00		
2. Railroad tracks, etc.	49,000.00		
3. Tunnels, bulkheads and wharf	509,648.00		
			$569,523.00
POWER HOUSE STRUCTURES			
1. Boiler, turbine and switch house	$1,772,004.00		
2. Coal bunkers	35,000.00		
3. Breaker house	90,000.00		
4. Screen house	42,220.00		
5. Office and machine shop	41,788.00		
6. Stacks and breeching	48,018.00		
			$2,029,030.00
MECHANICAL EQUIPMENT			
1. Boiler units			
a. Boilers	$201,691.00		
b. Comb. superheaters	99,500.00		
c. Furnace waterwalls	99,714.00		
d. Economizers	95,445.00		
e. Air preheaters	61,890.00		
f. Boiler settings	216,500.00		
g. Powdered coal equipment	372,563.00		
h. Fans	60,796.00		
i. Ash and soot removal equipm't.	46,500.00		
		$1,066,495.00	188,104.00
2. Turbine-Generator Units			
a. Turbine generators and supports	$959,808.00		
b. Condensers including pumps and air removal equipment	213,861.00		
		$1,164,669.00	
3. Auxiliaries			
a. Boiler feed pumps	$40,260.00		
b. Misc. pumps and air comp.	37,885.00		
c. Extraction heaters	25,715.00		
d. Generator air coolers	19,920.00		
e. Instruments, meters, etc.	38,410.00		
f. Evaporators	12,018.00		
g. Oil purifiers	7,650.00		
h. Cranes, traveling	32,500.00		
i. Coal-storage equipment	58,839.00		
j. Coal-handling equipment	78,433.00		
		$181,858.00	169,772.00
4. Piping, etc.			
a. Piping specialties, etc.	$302,395.00		
b. Heat insulation	60,000.00		
c. Air ducts and steel tanks	105,700.00		
		$468,095.00	
ELECTRICAL EQUIPMENT			
1. Electric switch and cont. equip't.		497,160.00	
2. Transformers		60,410.00	
3. M.G. sets emerg. turbine-gen.		53,260.00	
4. Light and power wiring and tel. sys.		345,563.00	
ENGINEERING AND MISC.		155,027.00	121,818.00
TOTAL COST		$4,001,537.00	$3,078,247.00
Cost per kw.		66.69	38.48
Total cost per kw.		$105.17	

Principal Features of Morrell Street Power Plant

GENERAL

Plant Location—Morrell St. & West Jefferson, Detroit, Mich.
Capacity (ultimate)—80,000 kw.; (installed)—60,000 kw.
Capacity per plant unit—20,000 kw.
Built for—Public Lighting Commission, City of Detroit.
Designing Engineers—Smith, Hinchman & Grylls.
General contractors—W. E. Wood Company.

BOILER EQUIPMENT

Boilers—Babcock & Wilcox Company.
Number, ult., 8; inst., 6; per unit, 2.
Type, Sectional cross-drum.
Heating surface, 9,571 sq.ft.; superheating, 3,640.
Steam conditions, 400 lb. abs., 730 deg. F.
Steam capacity, 200,000 lb. per hr.
Superheaters—Foster Wheeler Corporation.
Surface, sq.ft. convection, 3,420; exposed, radiant, 219.
Furnaces—Combustion Engineering Corporation.
Number, ult., 8; inst., 6; per unit, 2.
Type of furnace, Lopulco.
Total cooling surface, rad. sup. and water walls, 1,678 sq.ft.
Surface, side walls, sq.ft., 842; rear wall, 134; water screen, 483; rad. sup., 219.
Economizers—B. F. Sturtevant Company.
Number, ult., 8; inst., 6; per unit, 2.
Type, 2-deck, 2-pass, lead coated, 5,016 sq.ft.
Air Preheaters—Combustion Engineering Corporation.
Number, ult., 8; inst., 6; per unit, 2.
Type—plate, 10,980 sq.ft.

COAL PREPARATION AND BURNING EQUIPMENT

Coal Breaker—Pennsylvania Crusher Company.
Capacity, 200 tons per hour.
Magnetic Separators—Magnetic Manufacturing Company.
Coal Driers—Combustion Engineering Corporation.
Number, ult., 4; inst., 4.
Type—Lopulco, steam heat.
Drier exhausters drive—15 hp., 550 v. a-c. motor.
Pulverizing Mills—Raymond.
Number, ult., 4; inst., 4.
Capacity, 15 tons per hour.
Drive—200-hp. 450-r.p.m. a-c. motor.
Pulverizing Mill Exhausters—Raymond.
Number, ult., 4; inst., 4.
Drive, 100 hp. 1,200-r.p.m. a-c. motor.
Mill Auto Feeders—Raymond.
Number, ult., 4; inst., 4.
Drive, 1-hp., 900-r.p.m. 550-v. a-c. motor.
Pulverized Coal Collectors—Combustion Engineering Corp.
Number, ult., 4, inst., 4.
Pulverized Coal Conveyors—Combustion Engineering Corporation.
Number, ult., 2; inst., 2.
Type—screw; 32.5 tons per hour.
Pulverized Coal Feeders—Combustion Engineering Corporation.
Number per boiler, 10.
Type, Duplex.
Drive, 2.5 hp. 400-1,600-r.p.m. d-c. motor.
Pulverized Coal Burners—Combustion Engineering Corporation.
Number per boiler, 10.
Type, forced draft.

COAL AND ASH HANDLING EQUIPMENT

Supply received by barge (primarily) and railroad.
Two drag scrapers—R. H. Beaumont Co., 200 tons per hr.
Track Scale—Fairbanks, Morse & Co.
Boiler Coal Scales—Richardson Scale Co. (automatic weighing).
Coal Conveyors—Link-Belt Co.
Ash Hoppers and Gates—R. H. Beaumont Co.
Ash Removal Drag Conveyor—Combustion Eng. Corp.
Coal-yard storage capacity, 125,000 tons.

BOILER FEED

Sources of makeup, Detroit River water.
Feed Pumps:

Make, DeLaval Steam Turbine Co.	
Drive, 300 hp., d-c. motor	Steam Turbine
Number, 3	2
Capacity, g.p.m.-625	1,000
Head, lb., 550	550
Speed, r.p.m., 1,200	2,000
Stages, 10	5

EVAPORATORS AND HEATERS

Evaporators—The Griscom-Russell Co.
Number, ult., 4; inst., 3.
Capacity, 5,500 lb. per hour, at 203 deg. into vapor at 14.7 lb. abs., steam at 62 lb., 95 deg. sup.
Evaparator Feed Heater—The Griscom-Russell Co.
Number, ult., 4; inst., 3.
Capacity, 5,500 lb. per hour, from 55 to 203 deg. with steam at 14.7 lb. abs. 98 per cent dry.
Low-Pressure Extraction Heaters—Alberger Heater Co.
Number, ult. 4; inst. 3; 960 sq.ft.
Intermediate-Pressure Extraction Heaters—Alberger Heater Co.
Number, ult., 4; inst., 3.
Surface, 1,100 sq.ft.
High-Pressure Extraction Heaters—Cochrane Corporation.
Number, ult., 4; inst., 3.
Type, open, receiver, deaërating.
Capacity, 263,000 lb. water per hour, from 217 deg. to 312 deg., steam as 80 lb. abs., storage 500 cu.ft.

PRIME MOVERS AND AUXILIARIES

Main Turbine-Generators—Westinghouse Elec. & Mfg. Co.
Number, 3.
Capacity, 20,000 kw., 0.8 p.f., 1,800 r.p.m.
Throttle conditions, 385 lb. gage, 730 deg.
Emergency Turbine-Generator—General Electric Co.
Number, one non-condensing.
Capacity, 1,000 kw., 0.8 p.f., 3,600 r.p.m.
Steam at throttle, 385 lb. 730 deg.
Condensers—C. H. Wheeler Mfg. Co.
One per turbine, horizontal, surface, 2-pass.
Surface, 27,000 sq.ft.
Condenser Circulating Pump—C. H. Wheeler Mfg. Co.
Two per unit, 1-stage, centrifugal, 18,000 g.p.m. 20 ft. head.
Drive, 125-hp., var. sp., d-c. motor.
Condensate Pump—C. H. Wheeler Mfg. Co.
Two per unit, 3-stage, centrifugal.
Capacity, 600 g.p.m. 192 ft. head.
Drive, 100 hp., 1,750-r.p.m. a-c. motor.
Air Ejector—C. H. Wheeler Mfg. Co.
Number—2 per cent, Radojet, 20.6 c.f.m. at 1.5 in. abs.
Traveling Water Screens—Chain Belt Co.
Four, 10 ft. 8 in. wide; 5-hp. motor.

PUMPS

Sump Pumps—Yeomans Bros. Co.
Number and capacity—1, 100-g.p.m., Shone Air Ejector.
Service Pumps—DeLaval Steam Turbine Company.
Number, high press, 3; low press, 4.
Capacity, each, 1,000 g.p.m.
Heater Drain Pumps—DeLaval Steam Turbine Co.
Six, 100 g.p.m.
Emergency Condensate Pumps—DeLaval Steam Turbine Co.
Two, 600-g.p.m.
Test Pumps—DeLava' Steam Turbine Co.
One, 150 g.p.m.; one 750 g.p.m.
Screen Cleaning Pump—DeLaval Steam Turbine Co.
One, 200 g.p.m.
Low-Pressure Trap Receiver Pump—DeLaval.

OTHER MECHANICAL EQUIPMENT

Cranes—Whiting Corporation.
Turbine room, 100 t.
Screen wellhouse, 8 t., hand op.
Coal unloading, 5 t.
Locomotive Crane—Plymouth, gasoline.
Feed Water Regulators (Copes)—Northern Equipment Co.
Soot Blowers—Diamond Power Spec. Corporation.
Soot Conveyors—Girtanner Engr. Co.
Water Columns—Babcock & Wilcox Co.
Valves
Blowoff, hp. globe, hp. gate, Lunkenheimer Co.
Hp. check—Crane Co.
Safety—Consolidated, Ashcroft, Hancock Co.
Small hp. valves—Consolidated, Ashcroft, Hancock Co.
Atmosphere relief—G. M. Davis Reg. Co.
Reducing and low-press. valves—Crane Co.
Water Tanks—R. C. Mahon.
Motor Operators for Valves (Dean)—The Cutler-Hammer Mfg. Co.
Piping—Johnson Larsen Co.
Pipe and Duct Insulation—Philip Carey Co.
Steam Traps—Crane Co.
Heating System—Unit Heater, York Heating & Ventilating Corp.
Oil Purifiers—DeLaval Separator Co.
Number, 4 (225 g.p.h. each).
Oil Coolers—The Griscom-Russell Co.
Three, multi-whirl, (size 116).
Air Compressors—Bury Compressor Co.
Two, 600 c.f.m. at 70 deg. 110 lb.
Drive, 125-hp. 550-v. synchronous motor.

ELECTRICAL EQUIPMENT

Main Generators—Westinghouse Elec. & Mfg. Co.
Three, 20,000-kw., 1,800-r.p.m., 13,200 v., 3-phase, 60-cycle.
Emergency Generator—General Electric Co.
One, 1,000 kw., 3,600-r.p.m., 550 v., 3-phase 60 cycle.
Motor-Generator Sets—General Electric Co.
Service, 250-v. d.c., house supply.
Capacity, four, 500 kw. each.
Storage Batteries—Electric Storage Battery Co.
One set, 60-cell, 900-amp.-hr.
M-G Sets for Battery Charging—2 Westinghouse.
Generator Air Coolers—The Griscom-Russell Co.
Main Transformers—General Electric Co.
Three auto transformer, 25,000-kva., 13,200/24,000 v.
House Transformers—General Electric Co.
Four, 1,500 kw., 24,000-550-v.
Oil Circuit Breakers—Westinghouse E. & M. Co.
Capacity, 600 and 1,200 amp., 24,000 v.
Disconnecting Switches—Westinghouse E. & M. Co.
Lightning Arresters—Westinghouse E. & M. Co.
High-Tension Compartments—Deceleco cell structure.
Interlocks—Mechanical and elect., Chas. Cory & Son, Inc.
Auxiliary Motors—General Electric Co.
Switchboards—Westinghouse Elec. & Mfg. Co.

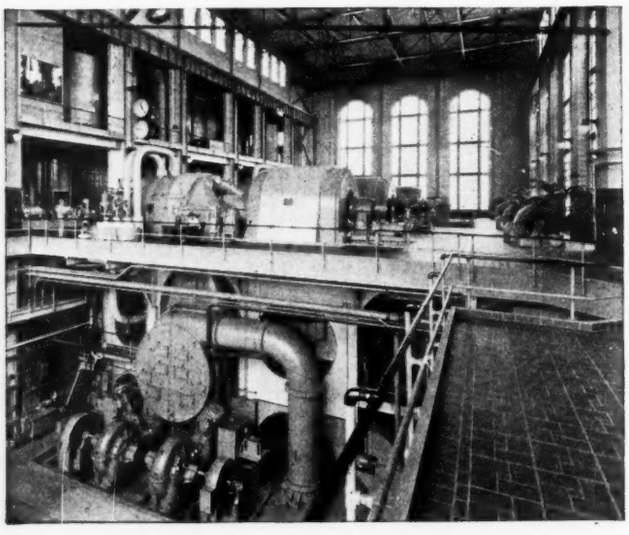
METERS AND INSTRUMENTS

Boiler Control Boards—Leeds & Northrup Co.
Flow meters (G. E.) Bailey Meter Co.
Draft gages—Bailey Meter Co.
Boiler—F. W. meters—Builders Iron Fdry.
Temp. recorders—Leeds & Northrup Co.
CO_2 recorders—Bacharach Ind. Inst. Co.
Pressure Gages—Foxboro Co., Inc., Consolidated, Ashcroft, Hancock Co.
Master Gages—The Ashton Valve Co.

powdered-coal bunkers. Each boiler unit consists of a cross-drum-type boiler with furnace water walls, combination superheaters, slag screens, economizers, air preheaters and forced- and induced-draft fans.

The main turbine-generators are designed for an initial steam pressure of 400 lb. absolute and a temperature of 750 deg., exhausting into a condenser with a back pressure of one inch of mercury. Power is generated at 13,200 volts, three-phase, 60 cycles, and is then stepped up through an auto transformer to 24,000 volts for distribution via underground cables.

Electrically, no less than mechanically, the new Morrell Street Plant has many features of more than ordinary interest to both large and small central-station companies.



Three 20,000-kw. turbine generators are now installed

As might be expected, most of the deviations from former conventional practice have been made in order to isolate disturbances and thus assure a continuity of service even greater than has been achieved by the city's older plants. This feature is of prime importance due to the fact that this plant is the only source of power and is not connected with any other source as is the case with large central-station companies. Many of the changes have increased the safety of station attendants as well.

Chief among the departures from standard practice are the following: Phase isolation of all electrical circuits and equipment (accomplished by the vertical segregated phase arrangement); interlocking of circuit breakers and disconnecting switches with remote-operating mechanisms on a separate floor; truck-type switchboard for 550-volt auxiliaries; simplified excitation with no automatic voltage regulation; duplication of house supply from each plant unit; a 1,000-kw. non-condensing turbine-generator for emergency house service and emergency lighting; provision of control circuit terminal room below the main switchboard control gallery.

In addition to these features unit electrical layout with ring bus arrangement is installed. The electrical gallery is separated from the power station proper. Reactors have been inserted in generator leads, feeders and bus tie circuits, and differential protection is provided on generators and transformers.

The construction cost of the plant amounts to $105.17 per kilowatt, the principal subdivisions being given in the table. All costs applying to the ultimate capacity of the present plant buildings have been segregated under the heading of 80,000 kw.; all other costs applying only to the present installed capacity have been segregated under the heading of 60,000 kw., the cost per kilowatt of installed capacity having been determined on this basis. This cost per kilowatt is slightly higher than it will be for the completed plant of 80,000 kw. capacity, but is a true index of the cost as the project now stands.

The plant was placed in service May 23, 1927. Operation of the Commission's former plant was discontinued within the next month and that of the Department of Street Railway's plants in April, 1928, the entire load having been transferred by that time. The output of the plant is now in excess of 12,000,000 kw.-hr. per month, and the coal consumption is under 1.2 lb. per kilowatt-hour net output delivered to the distributing system.

The plant was built under the direction of Frank R. Mistersky, general superintendent, and Louis J. Schrenk, superintendent of power plants for the Public Lighting Commission. Smith, Hinchman & Grylls were the designing engineers and architects and also superintended the construction work.

High Pressure Gases Produced Without Compression

By A. C. Blackall

London Correspondent

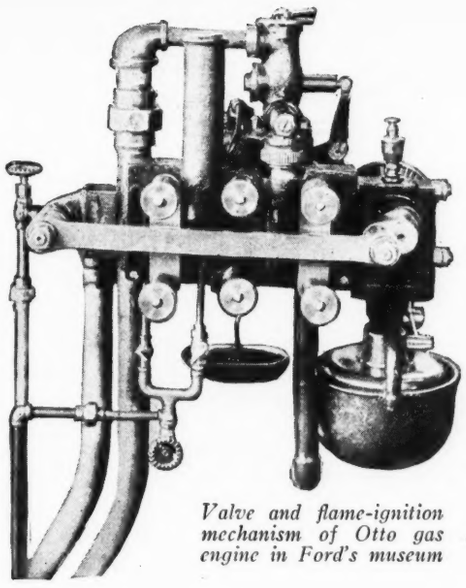
IN A paper read before the Society of German Engineers, Paul Hausmeister recently gave an account of the remarkable experiments on electrolysis under high pressures, which he has been conducting for more than ten years. Mr. Hausmeister has designed a water electrolyzer which enables the two component gases, hydrogen and oxygen, to be obtained either separately or together, as an ideal explosive mixture, under very high pressures. By a suitable arrangement of apparatus, without any surplus expenditure of energy, these gases are generated under pressures up to 1,865 atmospheres more cheaply than under ordinary atmospheric pressure.

As water is decomposed by electricity in a tightly filled and hermetically closed vessel, the gases thus produced are not allowed to expand, and therefore a very high pressure is developed.

According to current views the energy required to decompose water at high pressure should be greater than the amount used at atmospheric pressure, but the author had come to the conclusion that inasmuch as combustible gases under a surplus pressure themselves contain a surplus of energy, this should, at a given pressure, balance the electrical energy required to generate them.

Actual tests not only bore out this assumption, but showed that the current consumption with rising pressures actually decreases. Parallel tests made at the University of Gottingen led to the same results, and several physicists, including Einstein and Paschen, after some hesitation, had to declare that this was an unusual case of high-pressure production.

Instead of generating hydrogen and oxygen at ordinary pressures and then submitting them to a compression in special compressors with a corresponding expenditure of energy, the generation of these gases at high pressures is cheaper than under the usual experimental conditions. Dr. Noggerath, working at first independently, but now co-operating with Hausmeister, has obtained similar results.



Valve and flame-ignition mechanism of Otto gas engine in Ford's museum

HENRY FORD

and the

Otto Gas Engine

JUST as James Watt is recognized as the inventor of the steam engine, so we may claim for Dr. Nicolaus A. Otto the title of inventor of the gas engine. Otto and Langen in 1867 had made an atmospheric engine that was in advance of the other experiments. This, however, was not the goal of Otto's ambition. He foresaw that the gas engine was destined to be a successful rival of the steam engine, but he also perceived that it would be necessary for him to discard his atmospheric engine and build a new motor on entirely different principles, as the noisy operation and fuel consumption of this engine were objectionable.

The "Otto silent gas engine," which he invented in 1876, was the result. It was a revelation to the industrial and scientific world on account of its simplicity, economy and ingenuity of design. It marked the beginning of a new epoch in the development of the gas engine.

The Otto silent gas engine was patented in the United States, Aug. 14, 1877, bearing patent number 194,047. The firm of Schleicher, Schumm & Company, of Philadelphia, Pa., was licensed under the Otto patents to manufacture these engines in America. This firm later became known as "The Otto Engine Works," and now as the Otto Works of the Superior Gas Engine Company.

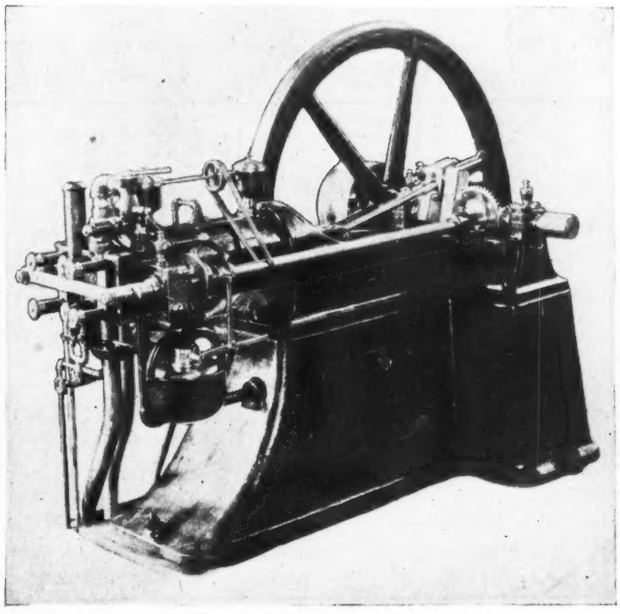
In 1879 Henry Ford was working at James Flower & Brothers in Detroit, learning to become a mechanic. While at this concern he read of this remarkable engine in an article titled "The Silent Gas Engine" in *World of Science,* an English publication. It was a few years later that Mr. Ford had occasion to see an Otto engine in operation at the Norriss Bottling Works in Detroit. For some years prior to this time Mr. Ford had experimented with steam engines and had hoped to use one in a horseless carriage, but when he saw the Otto engine he decided that the gas engine was the proper motive power for his horseless carriage. In the years that followed, he spent all his spare time developing his idea and experimenting with gas engines of the Otto four-stroke-cycle type.

Recently, Mr. Ford wished to have an Otto silent gas engine among the historical objects in his museum, and through the kindness of the Otto Engine Works, of Philadelphia, engine No. 954 (made about 1880) was procured from a printing shop in Dover, Delaware, where it had operated the presses for about 47 years.

The engine delivers two indicated horsepower at 180 r.p.m. and operates on the four-stroke-cycle. Unlike most present-day gas engines it has a slipper-type crosshead. The engine has a 50-in. flywheel and a belt pulley. It is mounted on a 3x7-ft. sub-base.

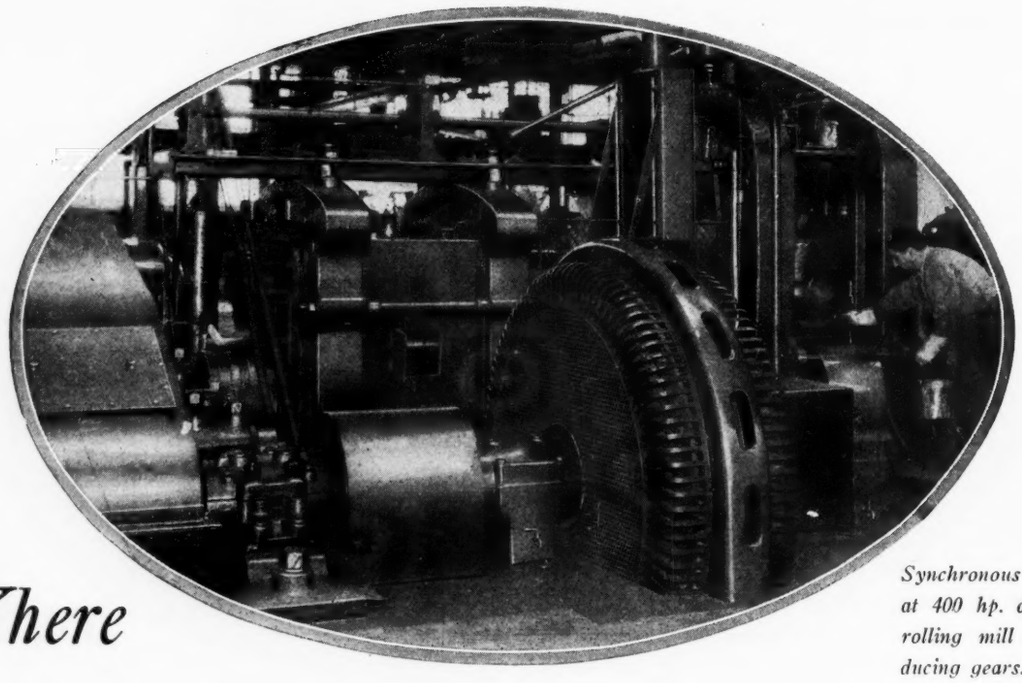
The bevel-gear-driven layshaft, corresponding to the camshaft of modern motors, extends the whole length of the engine. Through a connecting rod it drives a brass slide valve mounted in the cylinder head. This valve, which travels $2\frac{1}{2}$ in. across the end of the cylinder, contains a series of ports through which the gas and air are admitted.

Otto gas engine, built about 1880, *is now in Henry Ford's museum. Early knowledge of similar machines had a profound influence on Ford's career*



Two gas flames serve as the ignition. The outer flame relights the inner flame, which is extinguished by each explosion. Proper operation of the engine depends largely on the correct adjustment of these flames.

The governor, driven from the layshaft by bevel gears, actuates a sliding sleeve on the shaft on which a cam is mounted. This comes in contact with a lever which opens the gas valve and so regulates the speed. When the speed is too great the lever does not touch the cam.



Synchronous motor rated at 400 hp. driving brass rolling mill through reducing gears.

Where SYNCHRONOUS MOTORS *Are Applied*

By F. W. Hotchkiss

Engineer,

Electric Machinery Manufacturing Company

The author reviews recent improvements made in synchronous motors and their controllers that have made them applicable to practically every constant speed drive. Typical examples of difficult drives are cited and a chart given that shows 32 different applications in 50 different industries.

A LARGE expansion in the field of synchronous-motor application has taken place in the last few years. Conspicuous among the factors which have brought this about is an appreciation of the wastes caused by low power factor. Moreover, the design of the motor has received more attention than ever before. Improvements in starting characteristics and improvements in control equipment permit the motor to be used on applications formerly considered impossible.

Perhaps the greatest factor in this forward movement is an appreciation that inadequate starting torque of the earlier-type motors is a thing of the past. Although the self-starting synchronous motor, equipped with a squirrel-cage winding in the pole-faces, has been on the market for more than sixteen years, the present state of its performance has only recently been realized. Improvements in design, resulting from the progressive demands of a growing field of application, have caused the motor's torque characteristics to be greatly improved.

The starting torque of the modern synchronous motor, generally speaking, is as good as that of standard general-purpose squirrel-cage induction motors. It is easy to make it better, since the cage winding in the synchronous motor may be of high resistance without affecting the running efficiency. Also, the pull-in torque can be made quite high, but the starting torque and pull-in torque are not independent, and these two requirements must be adjusted in the design so that the one will not be unduly sacrificed to the other. The synchronous motor can be designed for a maximum running torque as high as can the induction motor.

On supply circuits that are subject to wide fluctuations of voltage, the maximum running torque of the induction motor may become much less than that of a similarly rated synchronous motor, for the reason that the torque of the induction motor varies as the square of the applied voltage, while the torque of the synchronous motor varies directly with the voltage. For example, if the line voltage falls to 0.8 of normal, the synchronous motor can exert 80 per cent of its nominal maximum torque, while the induction motor torque falls off to 64 per cent.

The variety and extent of

the torque requirements that are being met by modern synchronous motors may be illustrated by the examples given in the table.

In the rolling-mill field, brass-and-copper mills have received special attention, with the result that numerous rolls are now driven by synchronous motors.

In the steel mills the slip-ring induction motor and the direct-current motor continue to hold their own for those mills requiring flywheels, on the one hand, and those requiring adjustable-speed, on the other. But for constant-speed hot-metal mills without flywheels, the synchronous motor is a competent contender and is proving its suitability.

Tube-piercing mills and tube-rolling mills are becoming established applications for synchronous motors. It would appear, from data at hand, that about 26 per cent of all the motors purchased for rolling-mill drives during the year 1927 were synchronous motors. It is of interest to observe that the largest motor in rolling-mill service is of the synchronous type, rated 9,000 hp., 107 r.p.m., unity power factor, driving a continuous billet bar mill. It seems a reasonable prediction that synchronous motors will become the accepted type of non-reversing constant-speed drives in the steel mills.

Carbon-dioxide compressors are worthy of mention among comparatively recent applications. The first applications of synchronous motors to these compressors, by direct connection, were made about five years ago and have been followed by numerous successful applications. In some instances synchronous motors are starting CO_2 compressors without opening the bypass valve.

The starting of synchronous motors differs from that of induction motors in that it is necessary to apply excitation to the synchronous motor after it has reached the proper speed. The proper speed is approximately 95 per cent of synchronism, and the excitation should not be applied prematurely. For that reason control methods well adapted to induction motors do not adequately meet the requirements of synchronous motors.

The development of automatic starting equipment upon the principle of the frequency relay, actuated by declining frequency in the field coils as the motor gains speed, has met the requirements in this respect. The principle of control by frequency is especially desirable for loads of a variable nature. If the load is light, the motor accelerates rapidly and soon reaches the speed where field should be applied. If the load is heavy, the acceleration is much less rapid and the time required is correspondingly greater. Whatever the rate of acceleration the excitation will be applied to the motor when it has reached the proper speed, by the frequency-relay control.

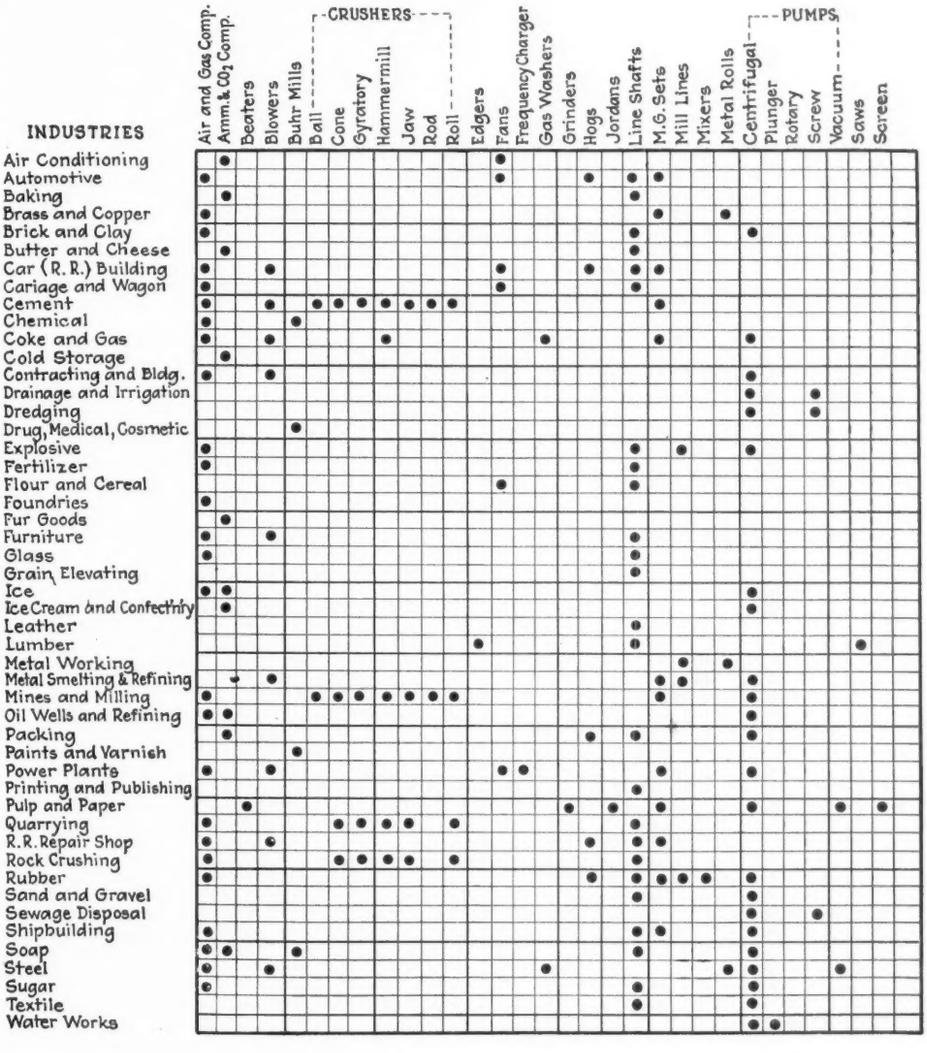
EXAMPLES OF SYNCHRONOUS-MOTOR CHARACTERISTICS

Drive	Motor Rating — Rated Hp.	Motor Rating — Rated Power Factor	Motor Rating — Speed R.p.m.	Starting Characteristics — Per Cent Full-Load Torque	Starting Characteristics — Per Cent Line Volts	Starting Characteristics — Per Cent Full-Load Amperes	Pull-in Characteristics — Per Cent Full-Load Torque	Pull-in Characteristics — Per Cent Line Volts	Pull-in Characteristics — Per Cent Full-Load Amperes
Direct coupling to shaft driving 7 flour-mill roll stands	300	Unity	600	105	80	385	100	100	350
Rubber-mill line	250	Unity	90	90	100	452	46	100	249
Hog use in reclaiming rubber	300*	0.90	900	112	65	368	256	100	490
Brass and copper rolls	350	Unity	109	55	100	286	24	100	169
Brass and copper rolls	100	Unity	600	88	80	330	54	100	195
Hammermill in cement plant	250†	Unity	720	150	100	550	115	100	300
Rock crusher	250	0.80	450	115 75 22	80 65 35	375 248 72	100	100	250

* The pull-out torque of this motor is equal to 300 per cent of full-load torque and it will resynchronize when the load has decreased to 150 per cent of normal.

† This motor is guaranteed to carry 600 hp. load at rated voltage without pulling out of step; to carry full rated load as an induction motor for five minutes; and to resynchronize when the load falls below 290 hp., when using the frequency-relay control described in this article.

Fig. 1—Chart showing synchronous motor applications in different industries



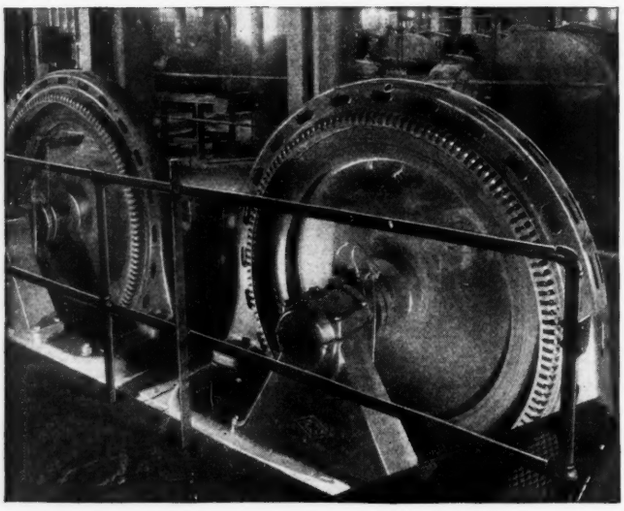


Fig. 2—Synchronous motors rated at 250 hp. each, driving refining lines in rubber reclaiming plant

Automatic starters have made the synchronous moto available for remote control, not only by push button, bu also by means of pressure switches, float switches, thermostats or other similar devices. Thus, a pump can be controlled by water level, a compressor or blower by the pressure, etc. The same motor can be transferred from automatic actuation to push-button control by throwing over a small double-throw switch.

A few years ago it was commonly stated that loads involving frequent stopping and starting were not adapted to synchronous motors. In the present state of the art such an assertion can be made only with reservations. With automatic starters frequent starting has become practical and dependable.

In the rubber mills synchronous motors of suitable characteristics, with automatic starters and electrical safety devices, have removed most of the difficulties of the old steam-engine drives and, in addition, have reduced the losses of power.

The driving motor for a rubber mill line must provide the following performance:

(*a*) High starting and accelerating torque, as shown in the table.

(*b*) High operating torque to take care of peak loads.

(*c*) Quick stopping in case of emergency.

In the earlier period of rubber-mill electrification these conditions were met by means of induction motors with clutches and mechanical brakes. The clutch provided high starting torque and also served to disconnect the motor from the mill when the emergency brake was applied.

Modern synchronous motors, capable of carrying peak loads of $1\frac{3}{4}$ to $2\frac{1}{2}$ times their normal rating, are quite suitable for mill-line drives. The first applications of such motors employed the clutch and brake, as used with induction motors, and such applications are considered good practice, but the tendency is to simplify the mechanical transmission by eliminating the clutches. To avoid the clutch it is necessary for the motor to develop high torque throughout the accelerating period, and it is further necessary to provide for quick stopping of the motor. Quick stopping is accomplished either by dynamic braking or by plugging the motor.

Another step in advance, brought about by the low-speed possibilities of synchronous motors, is to eliminate the gears. Motors operating at speeds of 80 to 133 r.p.m. are coupled directly to the mill lineshaft. With motors of such low speeds the problem of securing high torque for starting and accelerating the load is much more difficult than with high-speed motors, but many direct-coupled installations are now in operation, proving the success of this type of drive.

The control equipment for emergency stopping of motors direct connected to the mill line is exceedingly important. This may be arranged either for dynamic braking or for plugging. The dynamic braking system disconnects the armature of the motor from the line and short-circuits its terminals through a braking resistance, the excitation of the field poles being maintained until the motor has come to rest. The action is that of a short-circuited generator with full field excitation. The plugging method consists in connecting the motor terminals into reverse position on the supply line. The reversed torque tends to rotate the motor in the opposite direction after bringing it to rest, but this is prevented by automatically disconnecting the motor from the line the instant that it comes to rest. Very quick stopping can be accomplished by this method. The motors for such service are especially designed to withstand the mechanical stresses involved.

Exacting Torque Requirements

Hogs used in rubber-reclaiming plants, for reducing old tires and in other industries for various materials, have exacting torque requirements. The machine is provided with a great deal of flywheel effect. High peak loads occur during normal operation. For such an application as this the frequency-relay type of automatic control serves a special purpose. If a peak becomes so great as to pull the motor out of synchronism, the frequency relay immediately opens the direct-current field circuit, permitting the motor to continue in operation as an induction motor. When the motor's speed decreases sufficiently to allow the stored flywheel energy to become effective in disposing of the material that caused the excessive peak, it then resynchronizes automatically and resumes operation as a synchronous motor. The motor described in example 3 in the table is equipped with automatic control which operates in the foregoing man-

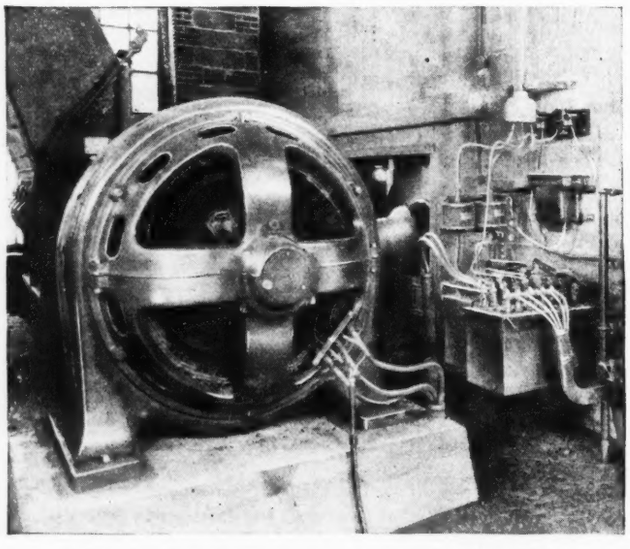


Fig. 3—Synchronous motor rated at 300 hp. coupled to a hog used in reclaiming rubber

ner. A reduction of the overload to 150 per cent of normal is sufficient to permit this motor to resynchronize.

The same functions are performed by the automatic control in connection with the hammermill motor in the table. The time of operation as an induction motor is limited by a thermal relay.

Across-the-Line Starting

The low-speed synchronous motors used in compressor service and for other low-speed applications, are now commonly connected directly across the line at starting. This is an important simplification, tending toward wider fields of application. Motors of moderately high-speed ratings may be started on full voltage when connected to a relatively large power generating system.

Across-the-line starting eliminates the auto-transformer and a portion of the switching equipment. This reduces the first cost, simplifying the operation of starting, minimizing the cost of maintenance, and eliminates the shock to the power system caused by transfer from reduced to line voltage with the reduced-voltage type starter.

Extension of Sizes and Types

As recently as 1919 the trade literature of a well-known manufacturer of synchronous motors contained this statement: "They cannot be used profitably on small loads, meaning less than 100 hp." Although an exception was made at that time to cover small synchronous motor-generator sets, apparently it was not foreseen that a demand for smaller synchronous motors for general service would be so soon forthcoming.

The trend has been particularly noticeable in the field of motor-driven ammonia compressors and air compressors. The low-speed motors required for direct-connection to the crankshafts of these smaller compressors are at present regularly listed in ratings of 20 hp., thus making the commercial line complete from 20 hp. up to the largest sizes required for such applications. These comparatively small engine-type motors are applied to compressors by mounting each motor in the space formerly occupied by the pulley-flywheel of the belted-type machines.

Flywheel Effect in Rotor

For compressors it has become recent practice to supply all necessary flywheel-effect in the rotor of the motor. This is done in different ways. The standard designs of one manufacturer cover the whole range of requirements by three forms of rotor:

1. The rim of the spider is designed with sufficient length and thickness to produce the required moment of inertia.

2. A solid extension, of greater diameter than the spider rim but of less diameter than the bore of the stator, is cast on the rim of the spider at one end.

3. A flywheel rim having a diameter approximately equal to the outside diameter of the stator frame is carried by spokes cast integral with the spider of the rotor.

Motors of the engine type, using the shaft and bearings of the driven machine, offer features that contribute toward their application. Rotors are commonly supplied with split hubs which permit them to be slipped to place on the shaft of the driven machine with comparative ease at the time and place of installation. They are clamped in place by hub bolts. The entire rotor is split, if so specified, for mounting the rotor between cranks. Split stators are obtainable in all but the small sizes.

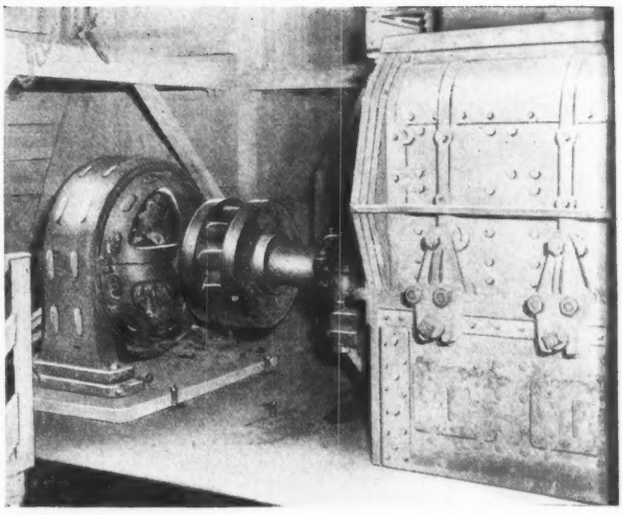


Fig. 4—Synchronous motor rated at 250 hp. driving a hammermill in a cement plant

Synchronous motors are regularly available in the same variety of mechanical forms as other motors. These include engine type, using the shaft and bearings of the driven machine, bracket and pedestal-bearing types for direct-coupling, or, with pulley, for belting to the load; pedestal types having three bearings for direct-gearing, silent chain, rope drive, or heavy belting; and vertical types adapted for connection to vertical shafts of any kind.

The idea of building-in the motor need not be restricted to small machinery or to motors of induction and direct-current types. This idea is particularly attractive for machines in which speed-reducing gearing can be wholly or partly eliminated by the application of a low-speed motor.

The synchronous motor is distinguished by its satisfactory characteristics at low speeds—far below the speeds that are economically practical with induction motors. This makes possible the advantages of direct connection for low-speed loads, served from an alternating-current supply. It was, in fact, the low-speed performance of the synchronous motor that made possible the built-in compressor drives, which are now standard practice.

Built-in synchronous motors are not confined to compressors, but are making their appearance in other kinds of machinery. An electric buhr-mill, with the buhr stone mounted on the vertical shaft of a built-in, ball-bearing synchronous motor, has been on the market for several years. A gyratory rock crusher, formerly belt driven, is now offered by its manufacturer with a built-in synchronous motor carried on the vertical shaft of the crusher, in the space formerly occupied by the pulley. In this motor the stator is internal and the rotor is the external part. Other examples could be cited, but these may suffice to show the trend.

A Correction—Edgar Station

Through a regrettable error two drawings were interchanged in the article "Four Years of Progress in High-Pressure Boiler Design,' on page 273 of the August 14 issue. These showed progress in boiler design in the Edgar station. The drawing labeled "1927" should have been shown over the caption "1925" and vice versa.

THE TEXTILE INDUSTRY

Turns to the Diesel

By Edgar J. Kates
Consulting Engineer, New York City

ALTHOUGH at the present time only a small fraction of the textile industry is powered with Diesel engines, the installations that have been made have proved so successful in delivering reliable power at low cost that engineers in the textile field should keep posted on what the modern Diesel engine might do for them.

The textile industry is composed of a number of diverse branches which differ greatly not only in the character of the product, but also in the relative use of steam and power in the processes of manufacture. This is clearly illustrated in Table I, compiled by George H. Perkins, showing the comparative fuel economy of the several important groups of the textile industry in which all the coal is charged to power.

In this comparison the best economy is shown by the cotton goods and cordage groups, because of their small demands for process steam. Woolen and worsted group, with a more general use of process steam still show a fairly low coal consumption. In the dyeing and finishing group the amount of power required is small in comparison with the need of process steam; hence the high coal consumption per unit of power. The coal consumption in the silk goods group is surprisingly high and is probably the result of wasteful use of steam.

The relation between the power demand and the heat requirements is a most important factor in choosing the best type of power. Recognition of this fact in recent years is responsible for the increasing use of private steam plants in establishments where the need of heat in the form of low-pressure steam is so large that all the power required can be produced by steam engines or turbines exhausting into the process lines. If in such plants all the exhaust steam is turned to practical account in the factory and none wasted to atmosphere or condenser, the heat

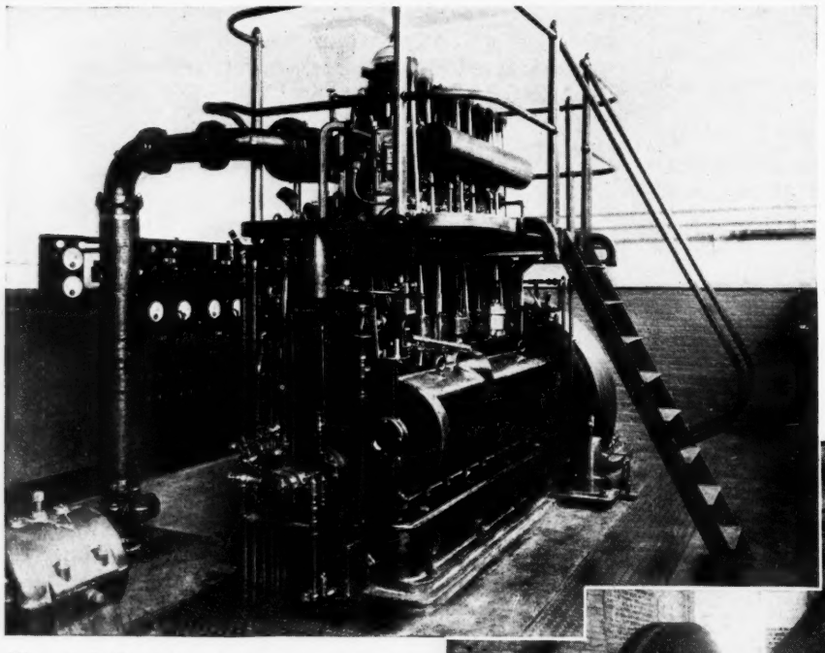


Fig. 1 (Above)—An Ingersoll-Rand Diesel in a silk mill

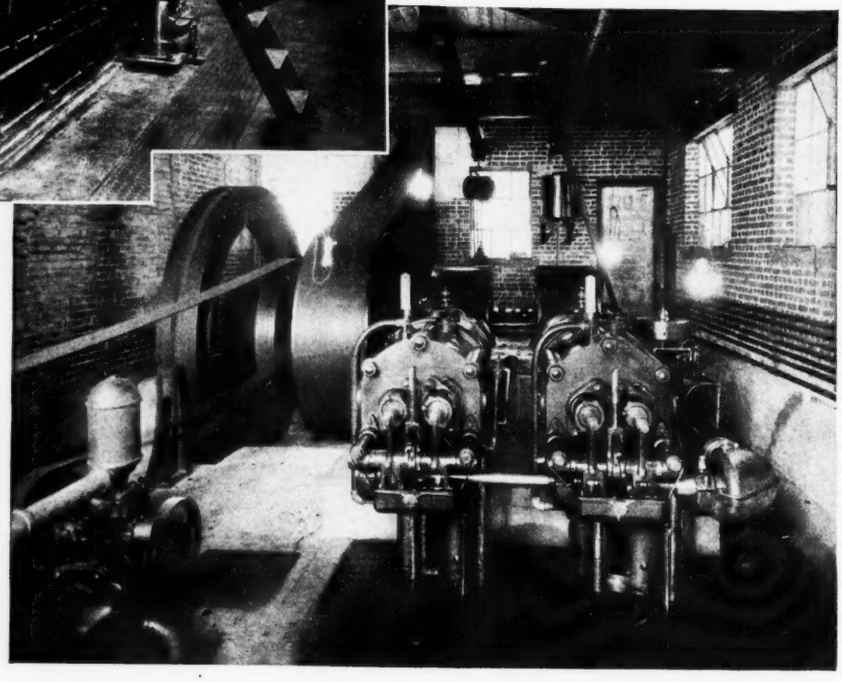


Fig. 2 (Right)—A New Jersey woolen mill has this De La Vergne Diesel

energy of the coal is so completely utilized that no other form of power can compete with it.

On the other hand, in establishments where but little heat is needed, a steam power plant can obtain no credit for the value of its exhaust steam, and consequently the cost of steam power is much greater. Most of the earlier textile mills were located upon rivers in order to make use of water power with direct drives to the lineshafting. This accounts for their isolated locations. Many of these mills outgrew the water powers and were faced with the necessity of installing steam power plants or buying central station power. Particularly in the case of cotton mills, where there is little use for exhaust steam, the cost of power in a medium-sized steam plant is higher than the price of electricity transmitted from a hydro-electric development or from a large steam central station. Consequently, many such mills found it profitable to purchase their power. At the time that central station current was generally introduced in the textile industry, the Diesel engine was in an embryo stage of development. It was comparatively unknown and therefore seldom considered in the studies of power problems. However, a few early installations were made, and their satisfactory performance is in a large measure responsible for the present greatly increased interest in Diesel power on the part of textile men. They cannot help being impressed by such records as that of a large woolen mill in New Jersey, which in 1914 added to its Corliss engine power a 100-hp. Diesel engine. In 1916 it installed a 450-hp. Diesel and is now erecting a third unit of 400 hp. Only a portion of the original steam plant is still in use: no electric power is purchased. The need of increasing the power supply arose after intervals sufficiently long to show the reliability and economy of each new unit, and the fact that Diesel engines were chosen each time, despite strenuous competition on the part of the electric-power companies, is evidence of their owners' satisfaction.

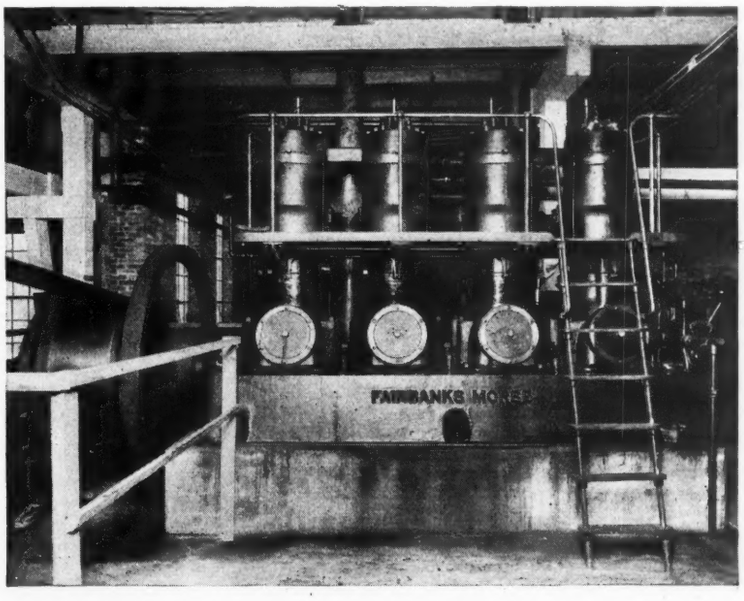


Fig. 3—This engine is in a Pennsylvania silk mill

In one silk throwing plant, that of Brawer Bros., at Weissport, Pa., where a 180-hp. Deisel is installed, the engine drives 8,000 spindles through line shafting. The average output is 4,350 lb. of silk per month of 572 hours. In addition to furnishing power for spindles, the engine drives a 10-kw. dynamo which lights the mill. Former electric bills averaged $950 per month, making the direct power cost per pound of thrown crepe, 21.8 cents.

The total direct cost of operating the 180-hp. engine per month for the same production averages $275. This includes fuel oil, lubricating oil, cooling water and gasoline. This makes a power cost per pound of thrown silk of 6.3 cents with Diesel power. The saving per pound is, therefore, 15.5 cents, or $675 per month, with a production of 4,350 lb. of silk. This amounts to $8,100 per year of twelve months, ignoring fixed charges.

In addition to this there was found to be a saving in attendance in the mill after the installation of the Diesel plant. As the Diesel gives a steadier speed condition than did the motors, one operator can attend to a greater number of machines. Also, it frequently happened with the motor plant that the power would go off during electrical storms, thus causing a great deal of trouble to the operators as well as a severe loss in production and a poor result in the silk.

No regular operator is used to care for the Diesel plant. The superintendent of the mill starts the Diesel on Monday morning and stops it on Saturday noon. A very small portion of one man's time is spent in periodically looking at the supply of lubricating oil, fuel oil and cooling water. The major portion of this man's time is spent entirely on duties in the mill. It may be asked why can a small mill power plant using Diesel engines show a lower cost than power purchased from a huge steam central station, in view of the fact that a small steam plant cannot do so. The reason is that, in the case of steam plants, size makes a great difference in initial cost and in operating cost per unit of output. A large steam power plant costs less per kilowatt than a small one, burns less fuel and employs less labor per kilowatt-hour. Consequently, the huge central station enjoys so large a margin in generating costs that it can afford to bear the loss and expense of long-distance transmission and still deliver the energy for a lower price than a small local steam plant can make it.

But if Diesel power is used, the small plant does not labor under such disadvantages. Because of the simplicity of a Diesel plant, the engine itself being substantially the entire installation, the initial cost is moderate, especially in these days when competition and large-scale production have brought engine prices considerably below pre-war figures. The fuel economy of Diesel engines is extraordinarily good, and this outstanding feature is enjoyed by small engines as well as large. The fuel consumption is less than 0.75 lb. of oil per kilowatt-hour. The cost of attendance is also low, since the modern Diesel engine requires but little attention and one man can take care of quite a large plant.

Many power users in the textile industry might obtain some useful information if they would estimate what their power costs would be if they installed their own Diesel plants. Such estimates can be made easily and accurately, as the cost of Diesel power is composed of only a few items that can be closely determined in advance.

The data in Table II were computed for the purpose of making preliminary rough comparisons with other sources of power. The running time has been assumed at 50 weeks of 48 hours each, or 2,400 hours a year. The average load while running was taken at 90 per cent of the engine rating. The cost of fuel oil was estimated at 6 cents per gallon delivered.

The principal factors concerned in the cost of Diesel power are: Initial cost of plant and percentage taken for fixed charges; fuel economy and cost of oil; cost of attendance; cost of lubrication; repairs and maintenance.

The cost of Diesel power plants is less today than ever before. Simplification of engine design, efficiency in manufacture, improvements in plant layout and severe competition have all contributed to a marked reduction in initial cost. Prices of engines run from about $45 to $75 per brake horsepower, while the cost of Diesel-driven electric plants complete, including buildings, ranges from about $160 per kilowatt in small plants to about $135 in very large ones.

In estimating the overhead charges to be assessed against a Diesel plant, consideration must be given to the

TABLE I—COMPARATIVE FUEL ECONOMY IN THE TEXTILE INDUSTRY

Group of Industry	Lb. Coal per Hp. per Hr.
Cotton Goods	3.12
Cordage, jute, twine and linen	3.48
Woolen, worsted and felt	5.20
Hosiery and knit goods	5.96
Carpets and rugs	7.26
Dyeing and finishing	10.00
Silk goods	13.36

TABLE II—COST OF DIESEL POWER IN TEXTILE PLANTS

(Based on 2,400 hours operation per year. Oil 6 cents per gallon.)

Size of plant in kw	200	500	1,000	2,000
Cost of plant	$32,000	$75,000	$146,000	$286,000
Annual fixed charges (12 per cent)	3,840	9,000	17,520	34,320
Annual operating expense	4,000	10,000	18,500	34,000
Total annual cost	7,840	19,000	36,020	68,320
Annual cost per kw	$39.20	$38.00	$36.02	$34.16
Annual cost, cents per kw.-hr.	1.81	1.76	1.67	1.58

fact that the depreciation item, which is so heavy in steam plants because it is really a charge for rapid obsolescence, is much less with Diesels. It is rare that a Diesel engine is supplanted because it is considered obsolete, for there has been but little improvement in the excellent fuel economy achieved at the very start. All wearing parts are easily replaced at a small proportion of the total cost of the machine, and most of the earliest engines are still in use after 25 years. It appears to be perfectly safe to figure depreciation upon a basis of 20 years of life; this corresponds to an annual charge of 2.72 per cent, assuming the depreciation fund earns 6 per cent interest. Adding the usual charges for interest, taxes and insurance gives 12 per cent as a fair estimate of the total overhead charges.

The steady load that is characteristic of textile mills is conducive to good fuel economy. Under these conditions Diesel engines deliver about 11 kw.-hr. per gallon of fuel. Unlike the steam power plant, Diesel fuel efficiency is permanently maintained in service; in most cases the fuel consumption just prior to an overhaul is not even 10 per cent higher than when the engine is in prime condition.

The cost of fuel varies with the location of the plant and can of course be easily ascertained in any particular case. A price of 6 cents per gallon delivered may be taken as typical for plants not especially favored, though some Diesel plants pay as little as 3 cents. Large plants, in which fuel costs are an important item, can well afford to install oil preheaters and filters in order to use the heavier oils, which are lower priced.

Attendance costs in Diesel plants are much lower than in steam because the boiler-room force is eliminated. When a Diesel engine is placed in an existing plant containing other power equipment, the same operating crew can usually attend the Diesel as well. In small plants wholly Diesel-driven, it is not necessary to employ a full-time engineer, as the engine can be equipped with automatic devices to control the water, fuel and lubricating systems and to give warning of any derangement. Thus a mill mechanic can take charge of the engine, and need devote only a small part of his time to starting, stopping and occasional attention.

Lubrication costs with well-made Diesel engines are quite low. With fuel oil at 6 cents per gallon, and lubricating oil at 70 cents, the cost of lubrication should not

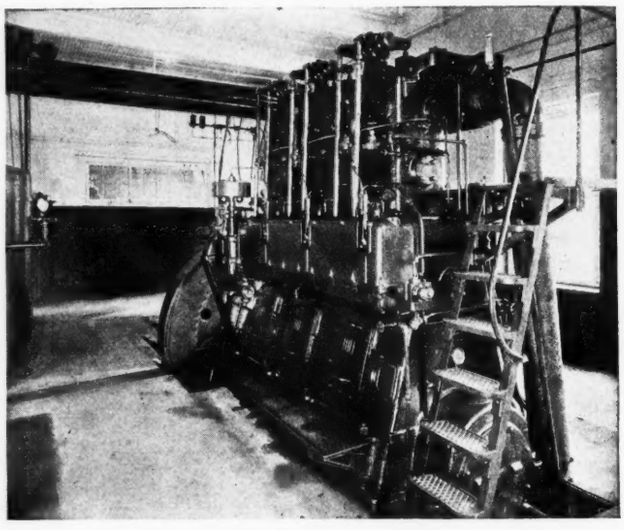


Fig. 4—This Diesel runs in parallel with a water-wheel in a Virginia woolen mill

exceed 10 per cent of the fuel cost, and is considerably less than this in the case of large engines.

The item of repairs and maintenance is usually overestimated because allowances for modern engines are often unthinkingly based on records of some of the earliest undeveloped machines. Diesel engines of today have been greatly improved in design, materials and workmanship, and their maintenance costs have been greatly reduced. Under the conditions obtaining in a textile mill the cost of repairs and maintenance, including both material and extra labor, may be reasonably estimated at $1.50 per year per rated horsepower.

When giving consideration to the use of Diesel engines in the textile industry, the utilization of the waste heat should not be overlooked. Where there is only a moderate demand for heat, as is the case in Southern cotton mills, the heat available in the Diesel jacket water and exhaust gases will often suffice. Even in Northern mills, where considerable heat is needed for building heating, it will be found that the Diesel waste heat will take care of the condition during the milder weather, thus reducing the costly period of fuel-fired boiler heating to about four months. By conserving the hot water discharged from the engine jackets and passing it through a heat reclaimer in the exhaust pipe, about 45 per cent of the original heat energy of the oil can be made useful in the form of hot water. Thus, from a gallon of oil a Diesel power plant will produce both 11 kw.-hr. of electrical energy and also over 60,000 B.t.u. of byproduct heat.

AIR CONDITIONING

Makes Possible Unique Office Arrangement

By R. B. Purdy
Assistant Editor of Power

FARRINGTON & EVANS are manufacturers of women's hats and recently moved their plant and display rooms to the ninth floor of a large building on Fifth Avenue, between Fifty-fifth and Fifty-sixth Streets, New York City. In making preliminary plans for this new establishment, they were confronted with an unusual layout problem.

It was highly desirable to locate the display rooms and offices close to the passenger elevators in order that prospective buyers might receive immediate attention without being required to walk through a long corridor. To do this at first seemed impossible, as the floor plan of the building was such that these rooms would be a considerable distance from the outside building walls, which therefore made the possibility of natural light and ventilation from windows unobtainable. The condition that existed can be seen by referring to Fig. 2, a floor plan of the building, showing the office arrangement desired. This plan, in addition to the advantage of having the display rooms close to the elevators, was also desirable because it permitted all the space required in the making of hats to be next to the windows, receiving the natural light and ventilation, so much appreciated by millinery workers.

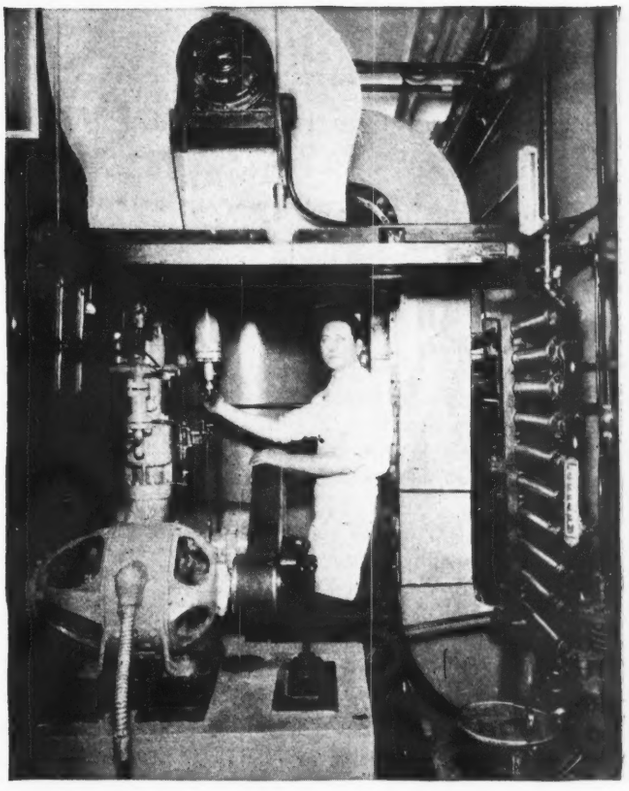


Fig. 1—The air-conditioning equipment occupies a floor space only 8 ft. wide by 14 ft. long

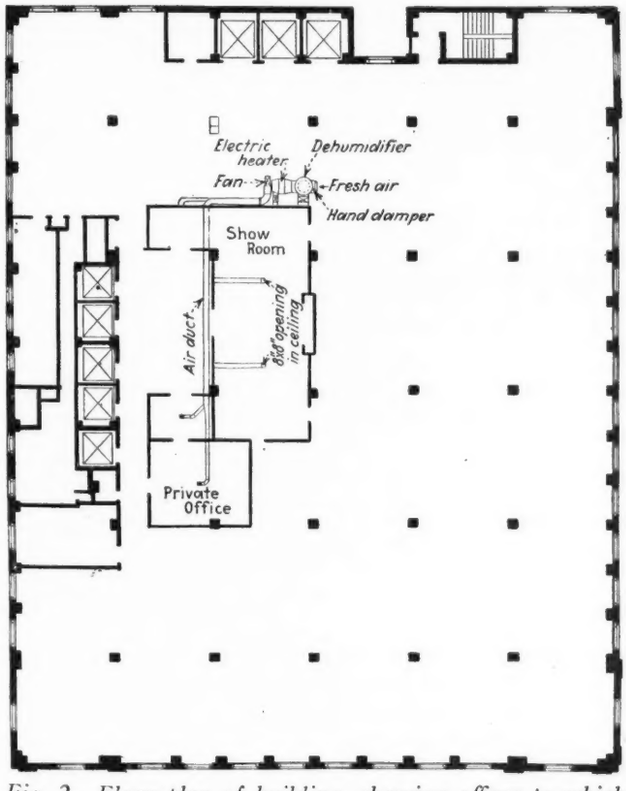


Fig. 2—Floor plan of building, showing offices to which air conditioning is applied

The advantages of this layout were considered sufficient to warrant the installation of an air-conditioning system that would maintain a comfortable and invigorating atmosphere in the office and display rooms near the elevators.

To accomplish this, a Carrier air washer, Brunswick & Kroschel 3-ton CO_2 refrigerating machine, pumps, fans and ducts were installed.

The capacity of the fan required for ventilating these rooms was based on the delivery of 30 cu.ft. of air per minute per person. It was estimated that there might be about 60 men and women in these offices at one time, and therefore a 2,000-c.f.m. fan was installed. It may be well to point out that this amount of air per person is not necessary to supply their oxygen needs, but is required to carry away the heat given off by the average individual, without causing an excessive increase in the temperature of the air, which in this case is between 8 and 9 deg. F.

About 75 per cent of the air is drawn through exhaust openings near the floor of the rooms to be ventilated.

The remaining 25 per cent is fresh air which is mixed with the return air before going to the air washer. The proportion of fresh air to recirculated air may be changed by adjusting the position of a damper in the fresh air duct. In the washer the air passes vertically upward through a fine spray of water, which, besides cleaning it, cools it to about 55 deg. F. Eliminators remove all the entrained water, and the air leaving the washer is saturated with water vapor at 55 deg. F.

The air at this temperature, if supplied to the rooms, would create considerable discomfort and might possibly be the cause of colds. Thus it must be tempered, which in this installation is accomplished by passing the air over a number of General Electric heater elements. Sixteen 500-watt elements are required, and these reheat the air to 68 deg. before it is delivered to the rooms through outlets in the ceiling, which are designed both to distribute the air efficiently and to blend with the general decorative scheme.

In Fig. 3, a picture of the display room, may be seen two of these ceiling outlets. A rectangle of greenish opaque glass is suspended about five inches below the outlet and the air delivered from the duct impinges upon the glass, spreading out uniformly in all directions along the ceiling. Since the air is colder than the atmosphere of the room, and therefore heavier, it gradually descends and diffuses throughout the room. In this way the room is maintained at a comfortable temperature of about 73 to 75 deg. and 45 per cent humidity.

In the base of the air washer are the refrigerating coils of the three-ton ice machine. These remove the heat absorbed from the air by the spray water and thus keep it at the required temperature.

A 17-gal. pump removes the water from the base of the washer and delivers it to the spray nozzles at a pressure of 40 lb. per square inch.

Automatic control has been installed, so that the system requires a minimum of attendance. A thermostat actuated by the temperature of the water in the base of the air washer stops the refrigerating machine when the water becomes too cold and starts it again as soon as it heats up. Another thermostat controls the electric heater. The fan and pump, however, operate continuously.

The system is started in the morning at 8 o'clock and is shut down at 5 p.m., making a daily operation of nine hours. When operating at maximum capacity, the total consumption of electric energy is about 14.3 kw. per hour, including the energy consumed by the heater elements. The daily consumption is therefore about 130 kw.-hr., which at 4.5c. a kilowatt amounts to $5.85 a day. A liberal allowance for attendance is one hour a day, which, at 90c. an hour, brings the total maximum operating cost, exclusive of maintenance, to $6.75. Considering the profitable use to which this floor space has been put, this does not seem an excessive cost.

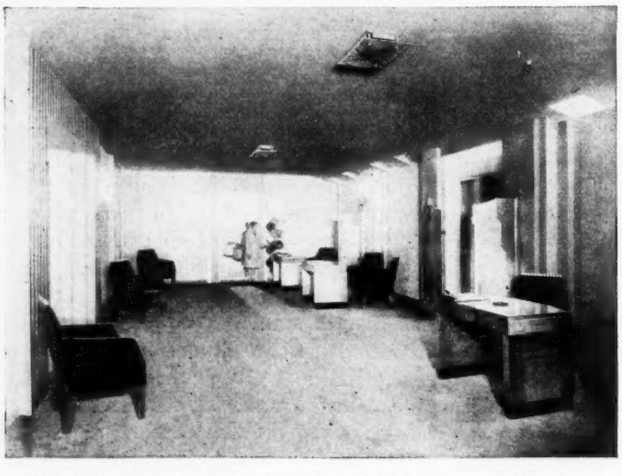


Fig. 3—Interior view of the display room, showing air outlet in ceiling

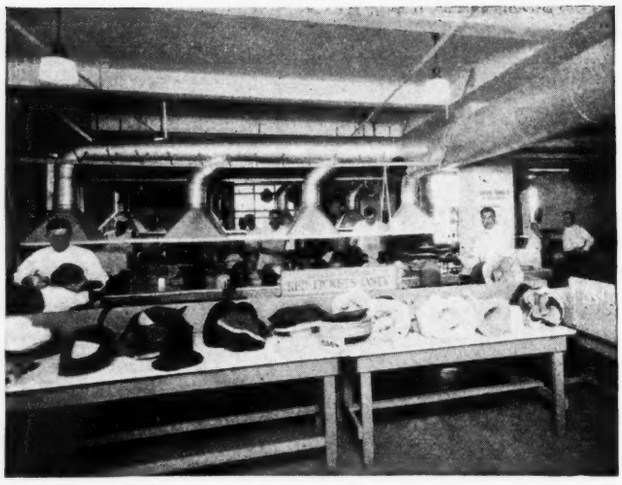


Fig. 4—Hoods for removing exhaust steam

A certain amount of steam is required in the shaping of the fur material from which the hats are made. This steam is exhausted directly into the room under ventilating hoods. A separate fan has been installed to remove this steam, thus maintaing more livable working conditions. Fig. 4 shows the arrangement of the ventilating ducts for this purpose. Additional steam is used during the winter months for heating and is purchased from the New York Steam Corporation.

Jones & Bacon were the engineers and architects consulted in the laying out of these office and manufacturing quarters.

Industries Use Refrigeration

In spite of the popular association of refrigerating machinery with ice making, it is industry that is showing the greatest increase in the use of refrigeration. For such varied manufacturing as rayon, steel, candy and oil refining, the refrigerating machine has become an essential piece of equipment, while for theaters, hotels, and interior rooms of office buildings, the machine has removed the terrors of torrid summer days. No important movie theater is now being erected without air conditioning apparatus, and the owner of more than one office building has found that a small compressor will make inside rooms as rentable as those facing the boulevard.

An Answer to the Question: When Does It Pay to Use

INCLOSED GEAR DRIVES

Instead of Open Gears or Belts and Pulleys?

BY JOSEPH A. MARLAND
Engineer, W. A. Jones Foundry & Machine Company

THERE are distinct classes of service where some one type of drive is best from the viewpoint of first cost, operating cost or quality and ultimate profit cost. In the light of this experience it has been found that no one type need possess all the cost advantages to justify its selection, although a careful check on the relative value and number of influencing factors can be made and the unit most deserving of the investment thus determined. The original leather belt and pulley or textile rope and sheave style of drive has found many modifications through adaptation to different conditions of service, including special shapes of woven textile material, flexible metallic forms of chain or belt, etc., aimed to increase traction and approach in positiveness the toothed gear. Flanges or crown facings were provided to prevent belts from falling off. Ropes in grooved sheaves and drums had their day. The stretching and wear of such textile or belt material, whether in rounded or straight-sided grooves or flat, variation of dependability with atmospheric conditions, objectionable center-to-center tension with power-wasting loads on adjacent bearings and hazards of personal injury limit this type of drive to service where some slippage is essential for ease in starting, as on air compressors, or safety against breakage of equipment or stalling of motor with too sudden loading, as in crushers, planers, punch presses, etc.

Where loss of power, danger of personal injury or wear of the comparatively heavily loaded bearings adjacent to such belts, ropes, chains or combinations of these types, or their own rapid deterioration are not objectionable, they may offer advantages in lower first cost and therefore are still frequently used and always may be best.

Such applications are usually in service requiring ratios of speed reduction between 1 and 6 to 1. Where higher ratios are required and it becomes necessary to use two or more reductions, then the advantage of first cost may be in favor of a more compact, inclosed drive.

However, the modern trend is toward the fully inclosed, self-lubricating type of drive, and many manufacturers who formerly preferred the traction drives have redesigned and improved their equipment, frequently in co-operation with, or on the insistence of, their customers, to employ the positive and eventually more profitable drives.

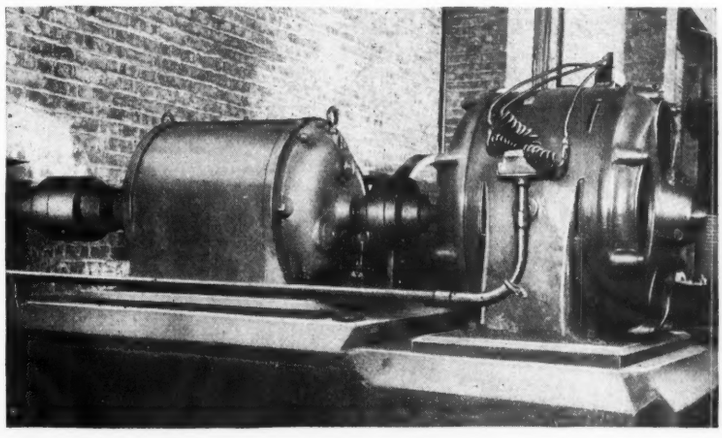


Fig. 1—Fully inclosed self-lubricating gear drive with ratio of 120 to 1 requiring only 15 per cent of floor space occupied by the drive, Fig. 2, which it replaced

Open gearing is used with satisfactory results in service where speeds are low, surrounding atmosphere is not abrasive-dust laden, personal injury hazard is remote, or where the mechanical conditions prevent proper inclosure. Ring gears on tube mills may serve as an example, although remarkable improvements have been made toward effective inclosure of even such ring gears by some manufacturers of this class of equipment.

FACTORS INCLUDED IN FIRST COST

Under this classification would be considered the following:

1. Floor space required by various drives as compared in Figs. 1 and 2, before and after views of the same drive, in which the inclosed drive requires only 15 per cent of the space necessary for chain and open-gear drives to perform the same operation.

2. Floor space in shape or convenience, as where right-angled or parallel shafts are required and surrounding

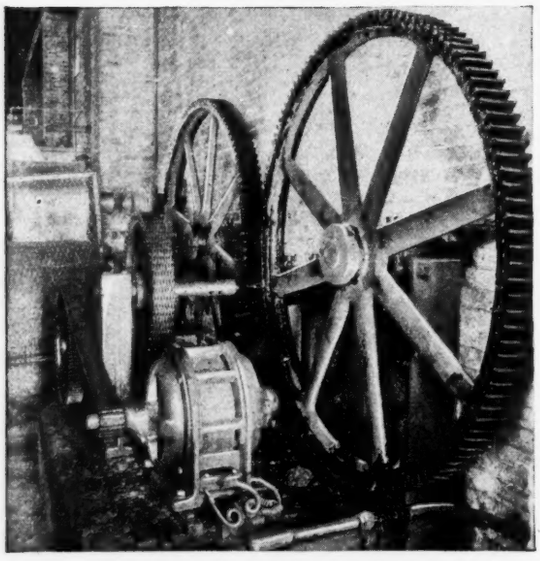


Fig. 2—Open-sprocket chain and gear drive. Notice the floor condition and the space occupied by this drive

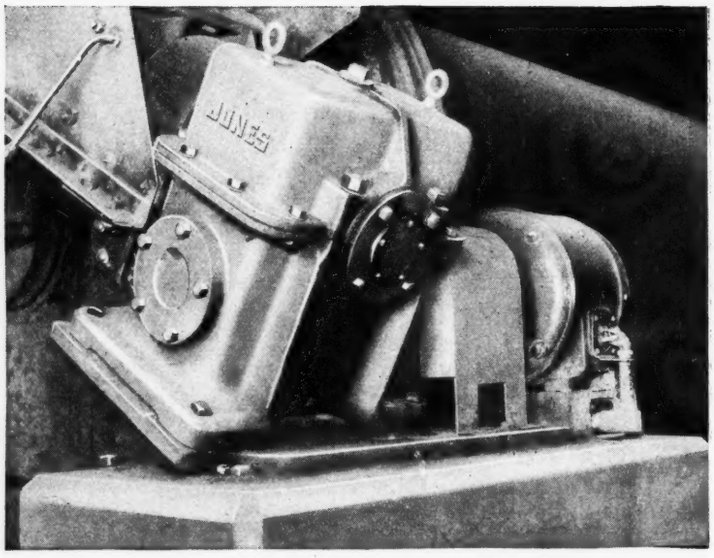


Fig. 3—Heavy-duty worm-gear reducer at inclination of 30 deg. driven by standard horizontal motor

machines or building lines are factors. See Figs. 3 and 4. The latter figure shows an inclosed drive with a ratio of 2,310 to 1, followed by a further reduction in sprocket and chain to a gasoline-tank conveyor on the floor below.

3. Draftsman's or designer's time to lay out and detail.

4. Purchasing department's time in ordering many small parts as against one complete drive.

5. Cost of material, including supporting channels, overhead beams, etc. Fatigue and failure of shafting, as well as hot journals and other bearing disturbances, are usually the result of deflection owing to cross-strain in the shafting. To carry heavy transverse loads successfully shafts must be designed and supported with all parts of ample proportions and suitably arranged to limit bending or deflection. Relief from heavy bending stresses often permits shafts of smaller diameter to be used when coupled to an inclosed reducer. This is particularly true where the power is taken off at several different points. At various points in the line where power is taken off to drive individual machines, the total concentrated load is relatively light, being only a fractional part of the total load carried.

6. Cost of special low-speed motors with slide rails, vs. standard higher-speed, less expensive and more efficient motors, sometimes permitting use of lower horsepower rated motors, owing to the more efficient type of drive with easier starting. As an example, Fig. 5 shows a Herringbone Maag frequent-starting skip hoist having all the gear teeth rack-generated to insure maximum of rolling action and mounted in roller bearings throughout,

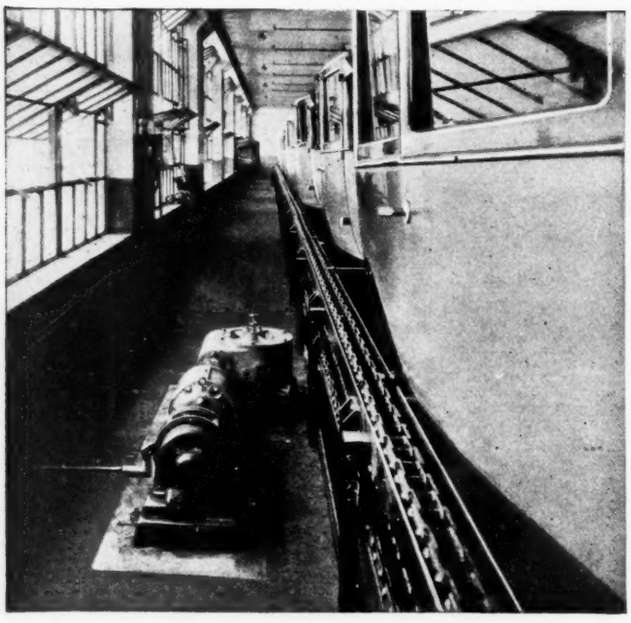


Fig. 4—Combination spur and worm drive suited to available floor space. Total ratio in inclosed gearing, 2,310 to 1

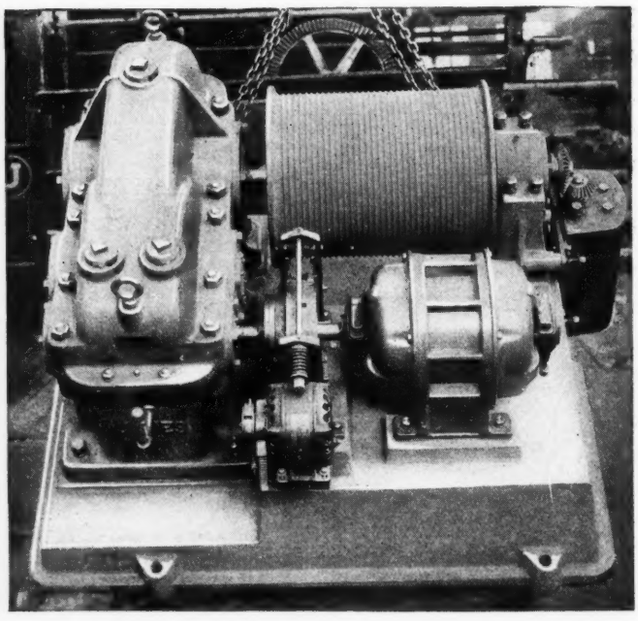


Fig. 5—Electric skip-hoist with roller bearings and rolling-action gear teeth, dust-tight, suitable for coal or ash handling

including the outboard bearing. The over-all mechanical efficiency of this type of drive is above 97 per cent, as against some other types with drives much less efficient and involving open gearing and plain bearings with heavy starting load.

This easy-starting unit finds application in coal or ash handling where the skip-hoist method is used, being particularly safe against dust or dirt. Once or twice a year lubrication is sufficient. All bearings and gears are automatically self-lubricated.

7. The cost of erection labor to assemble, fit and align. As an example of this, visualize an erection foreman sent out from the contracting office to the field or plant where the new equipment is being installed. The first need would be some experienced help, which he might have to recruit from the inexperienced, unemployed personnel in the vicinity. His time to train, supervise and correct them in properly erecting and aligning shaftings, bearings and hanger frames, in addition to checking the belts for proper splicing, tension, etc., would soon account for a considerable part of the difference that might exist between the open type and a fully inclosed gear drive in which all alignment has been taken care of, often including motor assembly in the shop, as shown in Fig. 5.

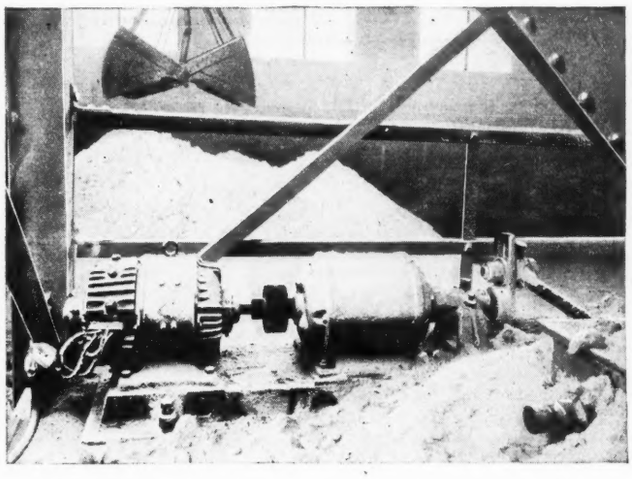


Fig. 6—Speed-reducing set, 3½ hp., ratio 140 to 1, driving salt plunger feeder in byproducts coke plant. It will be seen that operating conditions are far from ideal

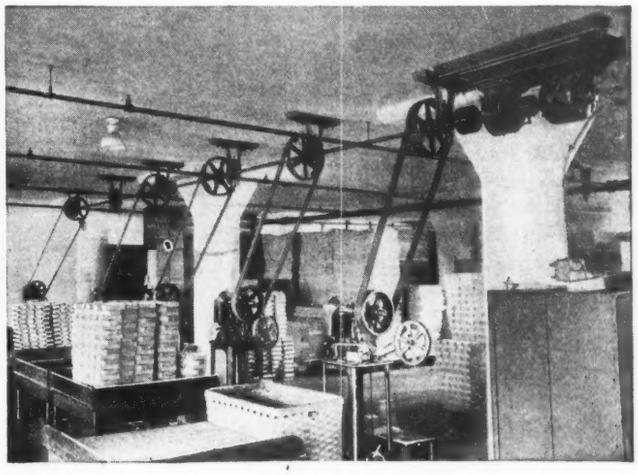


Fig. 7—Speed-reducing set driving lineshaft in paper-box factory. Rating, three horsepower; motor speed, 1,140 r.p.m.; final speed, 106.5 r.p.m.

Operating Cost a Factor

Under this heading, there are a number of items to be considered.

1. Maintenance labor to keep the belts or ropes in condition and proper tension and bearings oiled and aligned after the initial running in.

2. Belt dressing, lubricants and production time to apply them.

3. Cleaning oily floors or oil stains from product. An example of what can be done in this respect where overhead shafting must be used, is shown in Fig. 7.

All shafting or loose pulleys and friction clutches in such cases can be made with ball or roller bearings; thus lubricating attention once or twice a year would be ample to all overhead drive equipment, including the motor and gear drive, without danger of increasing the power losses.

4. Cost of personal injury accidents from flying belts, open gears, slippery floors.

5. Higher fire insurance rates where open gearing or bearing lubricants have saturated surrounding framework.

6. Destructive vibration of open gear drives to building foundations and adjacent equipment.

7. Cost of repairing bearings and windings of motors owing to heavy transverse loading when driving with belts, rope or open gears in contrast with straight-line torsional drive through flexible couplings.

8. Annual cost based on life of drive and whether desired to be temporary or permanent. This will depend on the industry and surrounding atmosphere (see Fig. 6). Appraisal or salvage value. A high-grade gear drive of reputable make can have a used market value equal or better in percentage of original cost than the motor that drives it.

Is the drive contemplated of sturdy, simple design, fundamentally correct, with no internal gears, bolts, nuts or cotter keys to loosen inside of the housing, or is it of the obsolete type with overhung pinion?

Naturally, these are factors that influence the life of the unit, since all inclosed gear drives are not designed on the same principle and will not render the same length of service.

Quality or Ultimate Profit Cost

In considering whether it might pay to use inclosed gear drives, the following costs also may be of interest:

1. The cost of non-uniform quality of the product owing to belt slippage or open gear chatter marks on the product, as in glass rolling mills.

2. Loss in value of product through weakening or breaking from slippage or vibration, as in paper mills using open bevel gears. This can be remedied by replacing such old bevel drives with inclosed, self-lubricating heavy-duty worm-gear drives of high efficiency.

3. Can a higher production rate be obtained safely with one type of drive over any other being considered?

4. Does the drive conform with safety-first laws, thus relieving the workmen of anxiety that might otherwise keep them from giving their best effort?

A careful and impartial analysis of various drives under consideration in the light of the foregoing should make it easier to determine the type for most profitable investment.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Turbine Oil Burner with Automatic Synchronized Control

IN THE Simplex turbine oil burner recently brought out by the Bunting Iron Works, 820 Parker St., Berkeley, Calif., the controls of the oil, air, stack and gas pilot are completely sychronized and automatically operated from the lowest to the maximum point of demand. Fig. 1 shows a phantom view of the burner and Fig. 2 the general arrangement of the complete control.

The lever *A* connects the main control of the burner with the diaphram regulator operated by the boiler pressure. At the burner the lever *A* is in turn connected to the oil control through link *B*, to the air control through link *C*, and to the gas-pilot control through link *D*. From the same regulator a cable is carried over suitable pulleys to a counterweighted lever on the stack damper. Thus all the various controls are synchronized and operated automatically by variations in the steam pressure.

In operation, as the steam pressure rises it expands the diaphragm of the regulator and forces the lever down. At a point halfway down, the lever reduces the oil supply and opens the expanding gas valve. At this point the oil valve locks until additional steam pressure moves the diaphragm farther. Then the valve arm shuts off the oil valve. At this point the position of the valves is again locked. When the boiler pressure drops, the regulator lifts the valve lever out of the second locked position into the first locked position, thus partly opening the oil valve, the gas pilot igniting the oil. A further drop in the steam pressure moves the diaphragm so that the lever opens the oil valve fully and closes the expanding gas pilot valve.

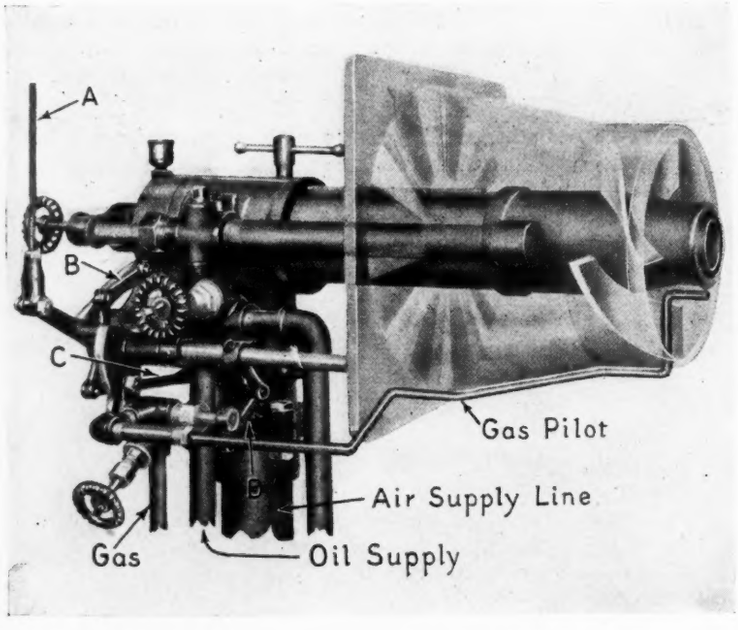


Fig. 1—Phantom view of burner with oil, air and gas-pilot control

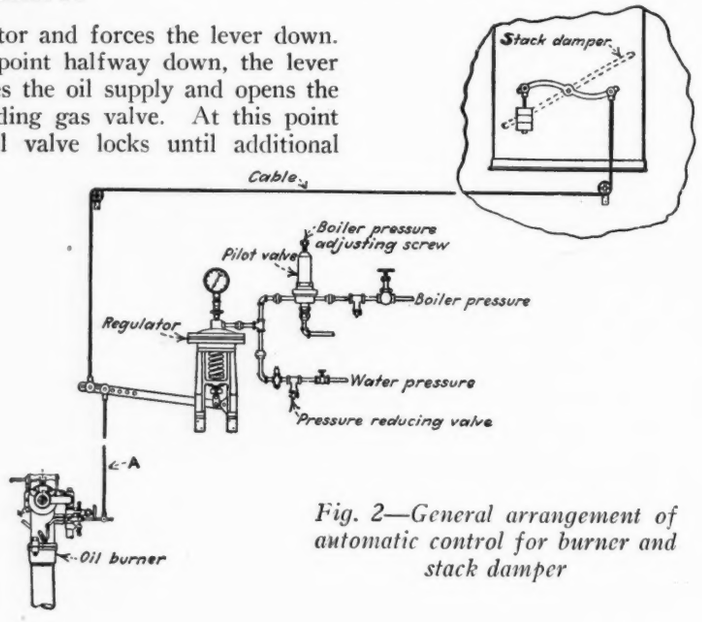


Fig. 2—General arrangement of automatic control for burner and stack damper

Auxiliary or secondary air is supplied through a duct surrounding the burner and is brought into intimate contact with the atomized oil at the point where it enters the combustion chamber. The direction of the flow of this auxiliary air is opposite to that of the main air current projecting the oil. This reversal of direction is accomplished by means of deflecting vanes at the nozzle point. This tends to give a longer flame travel and a more intimate mixture of atomized oil and air. The burner is designed for the use of high- or low-pressure boilers and for use with oil from 14 deg. Baumé up.

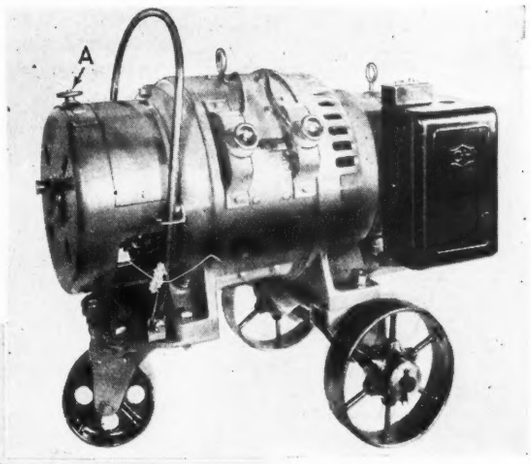
Water pressure for operating the regulator, the connections of which are shown in Fig. 2, can be taken from below the water level in the boiler or from the street service. When the street service is used a pressure reducing valve set at 5 lb. below the minimum water pressure is incorporated in the system.

Fuzon Arc Welder

A COMPLETE line of "Fuzon" electric-arc welders in the motor- and gasoline-engine-driven types, for both portable and stationary service, is being put out by the Fusion Welding Corporation, 103rd St., Chicago.

The welding generators are self-contained, in that all rheostats, switches and external stabilizers are eliminated. The excitation current is taken from the main brushes, and the current output of the generator can be set at any desired amperage by simply shifting the brushes. A short extension *A* from the brush-holder rocker arm passes through the frame of the machine, and the attached pointer reads in amperes on an index plate, as shown in the illustration. The stability of the arc, or the elimination of external stabilizers is accomplished by a special disposition of the commutating pole windings. The turns of the commutating coils are extended to, and completely imbedded in, the adjacent main pole flanges. The winding thus extended and surrounded by laminations functions in the two-fold capacity of commutating and stabilizing winding.

The index plate at the control *A* is calibrated to read correctly after the machine has been brought up to operating temperature. This single control reading directly in amperes, makes it unnecessary to purchase meters with the machine. The important advantage claimed for this single brush-shifting current control is that it tends to give a uniform arc over the entire range of output.



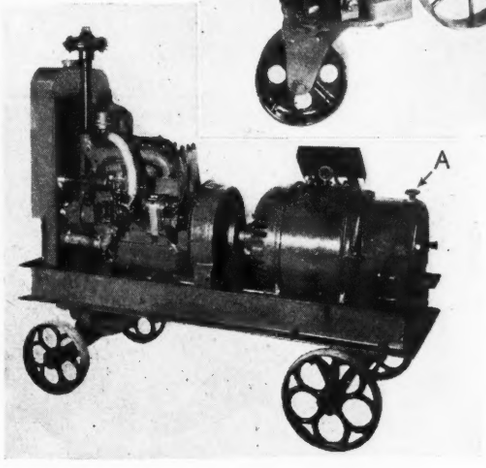
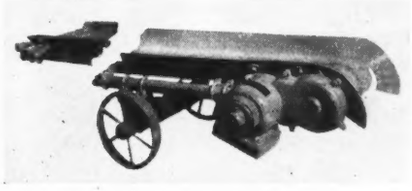


Fig. 1 (Above)—Motor-driven two-bearing unit

Fig. 2 (Left)—Engine-driven welder with single control

"Jax" Portable Conveyor

A SMALL portable conveyor, known as the "Jax," has been put out by the Link-Belt Company, 910 South Michigan Ave., Chicago, Ill. The conveyor is adaptable to a variety of uses, such as handling coal, coke, sand, etc., from cars or for loading the material into cars. The conveyor consists of an endless rubber belt running over the two pulleys mounted 12 to 15 ft. apart, on a framework that consists of two heavy pipes tied together at the ends. The conveyor rests on a pair of agricultural-type wheels which are movable to practically any point along the frame. The height of the discharge point of the conveyor can be adjusted by moving the wheels forward or backward along the conveyor frame. The wheels are also provided with a vertical adjustment for three positions.



Conveyor complete with motor drive

Conco "4" Condenser Tube Cleaner

THE Condenser Cleaners Manufacturing Company, 422 First Avenue, Pittsburgh, Pa., has recently brought out the improved cleaner and gun illustrated.

The cleaner, Fig. 1, consists of the hexagon cap *A* in which are inserted the scrapers or blades *B*, cleaner head *C*, compression spring *D*, and assembly pin *E*, which is riveted fast in the cap *A*.

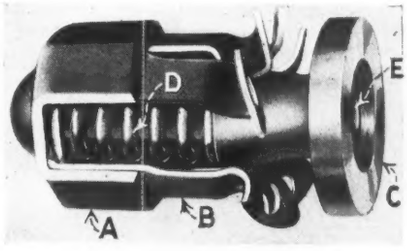


Fig. 1—Cutaway view of cleaner

The head *C* is made a sliding fit on the pin, and the inner end of the head is made cone-shaped, which serves to expand the blade *B* out against the tubes, these being held normally at the maximum diameter by the spring *D*. This flexible feature precludes any possibility of the cleaner sticking in the tube, for should the cleaner tend to stick, the water pressure against the head *C* tends to compress the spring and thus release the blades slightly from the tube wall. The head *C* is made about $\frac{1}{32}$ in. smaller in diameter than the tubes it is to work in. This allows water to leak past the cleaner and wash the dirt away as the scrapers cut it free and thus prevent clogging of the cleaner. Water at 100 to 150 lb. pressure is recommended for shooting the cleaners.

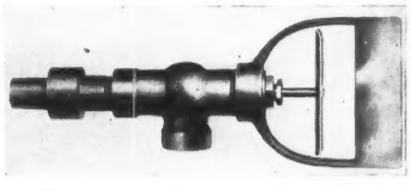


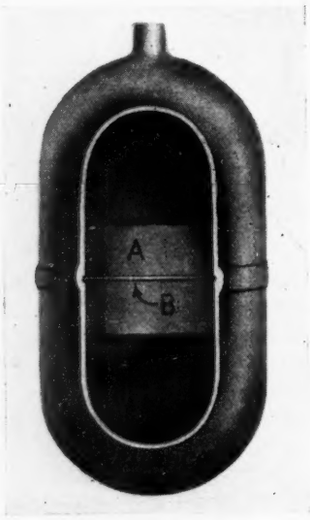
Fig. 2—Gun for shooting cleaners through the tubes

The gun, Fig. 2, consists of a quick-opening valve and nozzle and is designed especially for shooting the cleaner through the tubes. The cleaner are made for $\frac{3}{4}$-, $\frac{7}{8}$- and 1-in. tubes.

Monel-Metal Float for 1,500 Lb. Pressure

A FLOAT of monel-metal for use in safety water columns or other equipment operating under pressures up to 1,500 lb., is a recent development of the Reliance Gauge Column Company, Cleveland, Ohio.

The metal shell of the float is made in the form of two cups, which are



Monel-Metal float with steel bracing ring

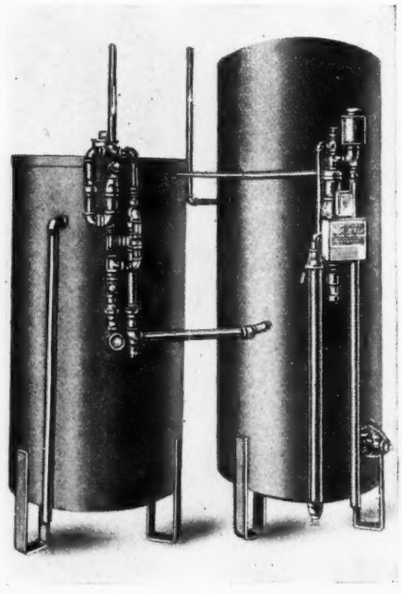
pressed onto the steel bracing ring *A* and then welded. The edges of the shell are slightly belled on the inner side, so that when the two halves meet, they form a groove into which the rib *B* on the bracing ring snugs. The halves are welded together at the joint.

Automatic Regenerating Water Softener

A TYPE of zeolite water softener in which the regeneration is entirely automatic and which is started by simply pressing a push button is a recent development of the Automatic Water Softener Company, 3421 Bigelow Boulevard, Pittsburgh, Pennsylvania.

The regeneration of the softener is controlled by the electric conductivity of the brine solution passing through the softener during the regeneration. Upon the pressing of a push button a salt solution is started on its course through the softener, and after a given charge has been introduced, the electrical conductivity of the brine passing through the softener is used as a means to shut off the charge itself as well as to hold open the valve controlling the flow to the drain, during the brine flushing out operation. As long as a brine solution is flowing to the drain, the drain valve remains open, but as soon as the brine is flushed out, the electrical conductivity of the water flowing to the drain becomes negligible, which in turn causes the drain valve to close and the soft-water line to be opened.

Construction of the valves that control the flow of water through the softener is comparatively simple. They are operated by the water passing around a piston rather than pressure acting on the back of it. In this construction the use of piston rings, stuffing boxes, or other water-packed joints is avoided. Regeneration of the softener can be effected



Water softener equipped for automatic regeneration

automatically or by hand control of two pilot valves, in the event of the electric current being shut off.

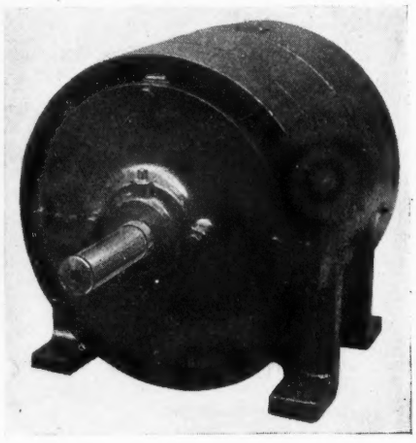
The softener, salting and flushing out of the brine solution are all done in an upward direction, with practically no loss in head pressure. This upward direction of regeneration tends to cause the suspended zeolite to be acted on more completely and to give an increase in capacity of regeneration for a given size of unit.

Simplicity of design is an important feature of the softener, in that there are only three moving parts controlling the flow of water and one moving part controlling the mercury switch and electrical equipment. The design of the moving parts controlling the flow of the brine and salt through the softener is such as to permit a generous clearance on all sides, thus precluding the possibility of the valves disks becoming stuck in the body, rendering them inoperative.

New Type Fan-Cooled Inclosed Motor

A NEW type totally inclosed fan-cooled electric motor has been placed on the market by the Cleveland Electric Motor Company, Cleveland, Ohio, and is designed to meet severe operating conditions. It is well known that the output of any motor is limited largely by the temperature rise. For this reason a totally inclosed motor is larger and more expensive for a given rating than is the open type.

The motor is built with a double shell. The inner shell, which contains the motor windings, is completely inclosed and entirely dust-proof. This inner shell is mounted in the outer shell, as shown in the figure, so as to allow a free air space between them, the shaft passing through both. One end cover of the



Completely assembled motor, showing air space between inner and outer shells

outer shell is provided with holes for admitting air.

At the end away from the motor pulley a fan is mounted in the space between the inner and outer end covers. This draws in a current of air through the holes already mentioned and blows it over the outer surface of the inner shell. Thus, although dust is excluded from the working parts, ample cooling effect is obtained. In fact, this type of motor permits practically the same rating for a given frame size as an open-type motor.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Diesel-Engine Courses Given at Brooklyn Polytechnic Institute

IN ORDER to meet the demand for information concerning the principles and operation of the Diesel engine, the Polytechnic Institute of Brooklyn, N. Y., offers an evening course in Diesel engines. This course was first given in 1923 and since that time some 400 men have taken advantage of it. These men represent a large variety of occupations, such as marine superintendents and operators, steam-engine operators, oil chemists and salesmen, railway men, tug-boat operators, insurance men and others who have to do with oil engines.

The course is not part of the regular undergraduate work of the institute, but is designed solely for the man interested in oil engines regardless of his previous education. Twenty lectures of two hours' duration are given during the winter, every Tuesday evening at 7:30, beginning with the last Tuesday in September.

To meet the needs of those who wish to train themselves for operating, building, selling or designing oil engines, the lecture course is supplemented by classroom exercises and laboratory periods. Several varieties of oil engines are available in the laboratory for demonstration and testing. Students enrolling for this work will meet every Monday evening, alternating each week between the laboratory and the classroom.

Naturally, a large part of the course is devoted to the characteristics and construction of the various types of Diesel and oil engines. Because of the importance of proper plant layout and proper methods of operation, considerable attention is given to these subjects. The present course also includes an extended study of the selection of suitable fuel and lubricating oils and a full discussion of the influence of each of the important properties such as viscosity, sulphur and carbon residue. The various tests for these properties are illustrated by classroom demonstrations.

Another new feature of the Polytechnic instruction concerns the economies of the modern oil engine. The fundamental requirements of a prime mover are reliability and low power cost, and the Diesel engine is properly applied in any particular case only if it satisfies these two essentials. The course accordingly treats of the reliability of the modern Diesel engine and compares actual oil-engine records with those of central-station electricity. In this connection the question as to the need of spare units is discussed. A circular describing the course may be obtained from Polytechnic Institute, at 99 Livingston St., Brooklyn, N. Y. The first two lectures may be attended without obligation.

The Institute believes that this type of co-operation should be of value to the engineering industry. It is offering similar courses in automotive engineering and heating and ventilating.

Standards for Pressure Gages Proposed

Because the safety of human life often depends upon the accuracy of the pressure gage on a steam boiler or other pressure equipment which can explode, the American Engineering Standards Committee has been asked by the American Society of Mechanical Engineers to approve the establishment of national standards for pressure gages. The standards might provide, for example, for such construction that the gage could not indicate a zero pressure when there is actually sufficient pressure to constitute a grave hazard if a workman should open a boiler or tank—a cause of loss of life in the past. Standardization of vacuum gages is also requested.

Grant of the request by the Standards Committee will be followed by the formation of a committee of technical experts to undertake the work of gage standardization. Besides decreasing the accident hazard, it is expected that the work will benefit manufacturers and purchasers of gages by replacing the great number of sizes and types now being manufactured by a comparatively small number of standard sizes and types based upon the findings of the committee of technical experts.

The United States Navy Department has done much important work in establishing gage standards for the use of the Navy, and several private concerns, such as the Firestone Tire & Rubber Company, the General Electric Company and the Pennsylvania Railroad Company have established specifications for their own use. It is expected that these and other specifications will be studied and co-ordinated in a national way.

The standardization of pressure and vacuum gages may include, in addition to specifications for accuracy and temperature of calibration, such items as ratings of capacity; arrangement of graduations, numerals, indicator hand, and certain features of the interior mechanism; and the position of stop pins. Establishment of standards for test equipment and standard methods for testing gages have also been recommended to the American Engineering Standards Committee.

Master Mechanics and A.S.M.E. To Meet at Textile Exposition

The Master Mechanics' section of the Southern Textile Association will hold a meeting in Greenville, S. C., on Tuesday, Oct. 16, during the Southern Textile Exposition. Every master mechanic is invited by the exposition management to attend this session and to visit the exposition.

Another event arranged for the Southern Textile Exposition is a meeting of the Textile Division of the American Society of Mechanical Engineers. This gathering will be held on Wednesday, Oct. 17, in the ballroom of the Poinsett Hotel. There will be present as honor guest, Alex Dow, president of the society. Jas. W. Cox, Jr., of New York City, Chairman of the section, will conduct the meeting. Also there will be present Fred R. Low, Editor of *Power*.

R. S. Twitchell Made Secretary of Boston Engineers

Richard S. Twitchell has been elected executive secretary of the Affiliated Technical Societies of Boston, succeeding Prof. John B. Babcock, of the Massachusetts Institute of Technology, who recently resigned on account of the pressure of other work after several years of able service in the development of this organization of engineering societies.

Mr. Twitchell is well known in New England engineering circles. He was educated at Stevens Institute and Cornell University; taught physics for four years, after which he was with the Western Electric Company for seven years in its New York office as office manager, general assistant to the manager of the contracting department and in general sales engineering work.

From 1910 to the fall of 1927 he was with the Westinghouse Electric & Manufacturing Company with headquarters at Boston, specializing in power apparatus sales and engineering

in both steam and electrical fields. For the last eight years he was Westinghouse representative on the electrical apparatus committee of the New England Division N.E.L.A., and is now engaged in steam and electrical consulting engineering, with offices at 12 Pearl St., Boston.

New Steam Plant Planned for Sydney, Nova Scotia

It is reported that the Dominion Coal Company is considering plans for the construction of a large new power plant, near Sydney, Nova Scotia, to generate the whole, or part, of its own southern colliery power requirements, which total about 100,000,000 kw.-hrs. a year. The plant, if built, will be modern in every way. It will burn powdered coal and will have the double effect of providing power as cheap as, or cheaper than, hydro, and improving the colliery employment situation by providing a new outlet for certain types of coal.

Sloan Elected President of New York Edison Company

At a meeting of the board of directors of the New York Edison Company held Aug. 28 the following changes in the executive officers were made: Nicholas F. Brady resigned as president of the New York Edison Company and was elected chairman of the board of directors. Thomas E. Murray, senior vice-president, has been elected vice-chairman of the board.

Matthew S. Sloan, president of the Brooklyn Edison Company, has been elected a director and president of the New York Edison Company, in complete charge of all operations, policy and management. Mr. Sloan will also continue to act as president of the Brooklyn Edison Company. John W. Lieb, vice-president, has been elected senior vice-president of the New York Edison Company.

The acquisition of the Brooklyn Edison Company by the Consolidated Gas Company brings to the New York Edison Company one of the youngest and most progressive public utility executives in the United States as its president in Mr. Sloan. Born in September, 1881, for practically the whole of his business life he has been connected with the public utility industry. From time to time he has been honored by fellow executives in public utilities throughout the United States and is now first vice-president of the National Electric Light Association, an office which virtually assures the incumbent of the presidency of that organization at the end of his term as vice-president.

He began his business career with the General Electric Company at Schenectady, N. Y., first in the apprenticeship test course and afterward as an outside construction engineer, installing General Electric apparatus for public utility companies. He installed for the Potomac Electric Lighting Company, Washington, D. C., the first 2,000-kw. turbine, and was later in charge of the General Electric service installation at Birmingham, Ala. On finishing this job, Mr. Sloan became associated with the Birmingham Railway, Light & Power Company and was with them from 1906 until 1913, first as chief engineer and afterward in various supervisory positions, and finally assistant to president with supervision over all departments.

In 1913 Mr. Sloan became vice-president and general manager of the New Orleans Railway & Light Company, which position he held until 1917. In the latter year he came to New York as assistant to the vice-president and general manager of the New York Edison Company, and in July, 1919, became president of the Brooklyn Edison Company.

Recent Applications Made to Federal Power Commission

Six applications for permit or license under the Federal water power act were filed with the commission during the period July 27 to Aug. 25, 1928, making the total of 921 received to that date:

The Virginia-Carolina Power Company (of North Carolina) has applied for a preliminary permit for a power project on the Roanoke River, in Halifax, Northampton and Warren Counties, North Carolina, and Mecklenburg and Brunswick Counties, Virginia, near Roanoke Rapids, N. C. The company proposed to construct two dams: (1) a dam across the river near the head of Clements Island, about nine miles upstream from Roanoke Rapids, forming a pond extending to the tailrace of the Buggs Island plant of the Roanoke River Power Company; (2) a dam at the existing dam of the former Roanoke Rapids Power Company, 7½ miles downstream from (1), and 9 miles upstream from Weldon, N. C., forming a pond extending to the tailrace of the first, developing a head of about 42 ft. A power house will be built at each dam.

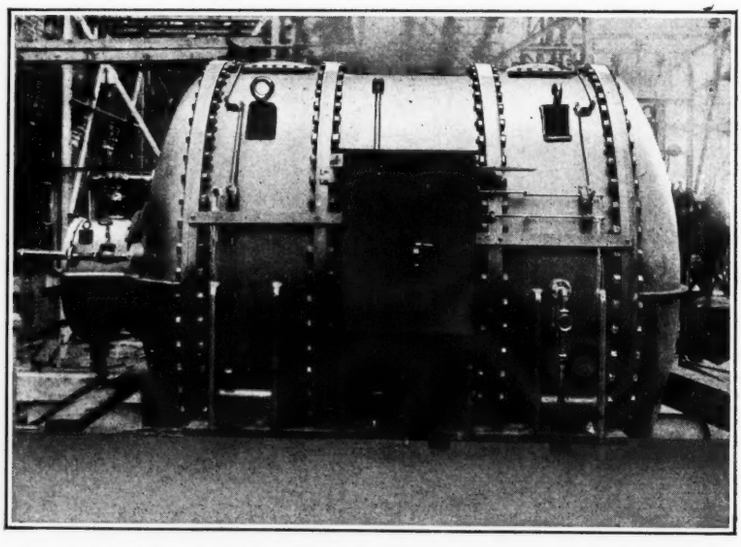
The power proposed to be developed will be sold to the Virginia Electric & Power Company for public utility purposes. The estimated capacity of the two projects is 23,200 hp.

The Commonwealth Mining & Exploring Company has applied for a preliminary permit to construct a diversion dam, conduit, power house and transmission line on Davis River, in the Hyder Recording District, Tongass National Forest, Alaska. The capacity of the project is estimated at 10,000 hp., proposed to be used in the company's mining and milling operations, the surplus, if any, to be sold to near-by camps.

The West Virginia Hydro-Electric Company has applied for a license for a concrete dam with a head of 32 ft., a reservoir one mile long and a power house with three hydro-electric units of 7,000 hp. each. The proposed project is to be located on the New River, near Hinton, in Raleigh and Summers Counties, West Virginia.

Robert H. McNeill has applied for a preliminary permit to construct a project

Synchronous Condenser Filled with Hydrogen Gas for Cooling



For the last three or four years there has been considerable discussion on the advantages of cooling electric machines with hydrogen gas. The first unit of this type, a 12,500-kva. synchronous condenser, has gone into operation on the New England Power Company's system at Pawtucket, R. I. If the machine were air-cooled its capacity would be reduced to 10,000 kva. The machine is inclosed in a gastight explosion-proof cylinder, as shown in the figure.

on the Tennessee and Duck Rivers, in Trigg, Marshall and Calloway Counties, Kentucky, and Stewart, Henry, Houston, Benton, Humphreys, Perry, Wayne, Decatur and Hardin Counties, Tennessee. The applicant proposes to construct a dam about 60 ft. high at the Aurora dam site, 42 miles above the mouth of the Tennessee River and 5½ miles north of the Kentucky state line. A power house will be built at the dam. This project will provide (if and when the Cove Creek project is built) a power capacity of 132,400 hp., which is intended for use for public utility and industrial purposes.

Canada Makes Rapid Progress in Water-power Development

Inside of two or three years Canada will have in operation at least four hydro-electric plants each, when completed, capable of generating more than 500,000 hp. of electric energy. The first half-million horsepower hydro-electric station was the Queenston plant on the Niagara River, built for the Ontario Hydro-Electric Power Commission, and completed in 1925. This plant, the world's greatest individual installation, has a normal operating capacity of 525,000 hp. This year the Isle Maligne plant of the Duke-Price Power Company on the Saguenay River in the province of Quebec enters the half-million horsepower class with the installation of the eleventh unit rated at 45,000 hp. When the twelfth unit is installed, the Isle Maligne station will have a capacity of 540,000 horsepower.

At the present moment the Alcoa Power Company, subsidiary of the Aluminum Company of America, is actively engaged on construction of a station at Chute-a-Caron, also on the Saguenay River, which will ultimately develop 800,000 hp. Then, at the opposite end of Canada work has begun on the driving of a two-and-a-half-mile tunnel which will deliver the waters of Bridge River, British Columbia, to a power station on Seton Lake, where the British Columbia Electric Railway Company will ultimately develop about 700,000 hp. These four great stations will deliver an amount of power equivalent to the entire developed water power in Canada in 1918.

There are other developments that might be considered as being in the same class. On the St. Maurice River, in the province of Quebec, the plants concentrated in a distance of twelve miles and principally owned or controlled by the Shawinigan Water & Power Company, now have an installed capacity of 557,000 hp., and before this year is ended the amount will be 600,000 hp. At the same time the company is actively engaged in planning the development of another stretch of the St. Maurice River, where ultimate installation is expected to equal or exceed the present development. Fifty engineers are now at work making a water-power survey of the upper reaches of this river.

On the Gatineau River, the Gatineau Power Company's three interconnected plants will be bought up to 436,000 hp. this year, while the planned capacity is 562,000 hp. The Winnipeg River is another of Canada's notable power streams, where installation this year will exceed 300,000 hp. and other installations are in prospect.

It has been estimated that the actual turbines being installed in the Dominion this year, which will have a total generating capacity of about 550,000 hp., will deliver more energy than the entire installation of waterwheels in Canada at the end of 1905.

Eustace C. Soares Returns to Consulting Engineering Field

After serving for nearly five years as manufacturing and markets editor of *Electrical World,* Eustace C. Soares resigned Sept. 1 to become an officer of the R. B. Engineering Corporation, 11 West 42nd St., New York City, consulting engineers. Prior to joining the staff of *Electrical World* Mr. Soares for more than four years was connected with Ophuls & Hill, Inc., consulting engineers, of New York, as electrical engineer in charge of all electrical operations. During that time he was associated with the design of a number of plants both in the United States and abroad, including the largest ice plant in the world.

Eustace C. Soares

The technical education of Mr. Soares was obtained at the American School of Correspondence and at Cooper Union, New York. He holds a license as professional engineer in the State of New York. In addition to his work as an editor and consulting engineer Mr. Soares has a broad knowledge obtained from a varied experience with central-station and manufacturing companies. He has been at different times connected with the Westchester Lighting Company, the Brooklyn Edison Company and the United Electric Light & Power Company, and previous to his association with Ophuls & Hill he was identified for four years with the Crocker-Wheeler Electric Manufacturing Company in its testing, maintenance and repair departments. Before joining the staff of *Electrical World,* Mr. Soares was a frequent contributor to the *Electrical World* and *Industrial Engineering.*

New Government Publication on Research To Unite Science and Technology

A new Government monthly publication, the *Bureau of Standards Journal of Research,* has been started by the Bureau of Standards to replace the two series of research papers "Scientific Papers" and "Technologic Papers," heretofore issued: Forty-four volumes of the two superseded series (22 of each) have been published, comprising some 942 research papers. Of these, 572 were on fundamental science and 370 on applied science.

The new journal will contain the Bureau's research papers and critical reviews in the fields of science and technology. These will be comparable in interest and importance with the Bureau papers already issued. The union of pure and applied science in one journal will, it is believed, tend to bridge the gap between the two fields, and by so much shorten the lag between discovery and its application. This makes it the more desirable that all engaged in scientific or technical work should have the new journal available for current use and permanent reference. Each semi-annual volume will be indexed and a cumulative consolidated index will be included in the Bureau's list of publications as heretofore.

Bureau Researches concern specifically fundamental science and the laws of matter and energy; physical constants and other basic data in the form of tables, equations, nomograms, or other graphs; the properties of materials, structures, and devices and their effective design and performance; the mitigation of injurious effects of such agencies as fire, corrosion, breakage; the promotion of efficiency by scientific measured control of processes through experimental and theoretical research in the fields of physics, chemistry, engineering, and the special technologies, such as electricity, magnetism, radio communication, photometry, spectroscopy, colorimetry, polarimetry, atomic physics, mechanics, sound, aeronautics, metallurgy, radioactivity, length, mass, capacity, density, time, radiometry, electrochemistry, gas chemistry, heat and power, thermometry, pyrometry, fire resistance, refrigeration, textiles, paper, leather, rubber, structural materials, cement, ceramics, optical glass, and other materials.

Several hundred researches are in progress at the Bureau of Standards, and the outlet for the results is the *Bureau of Standards Journal of Research.*

New Power Project for Panama Canal

Representatives of the U. S. Geological Survey are en route to Panama to conduct foundation investigations in connection with the Alhajuela dam project in Panama. The proposed dam is to be 150 ft. high and will provide additional storage and hydro-electric power for use in connection with the operation of the Panama Canal. Actual work is expected to start this fall at the end of the rainy season. With the increase of traffic through the canal it has become necessary to provide against an unusually prolonged dry season. It practically has been decided to abandon the idea of constructing a railroad to the dam site. It is believed that the materials can be handled to advantage by truck. The fourteen miles of highway which will have to be constructed will form a link in the inter-oceanic road.

Electric Power Gives U. S. Worker Advantage Over British Labor

Eight selected major industries of the United States, whose workers have at their command an average of one and one-half as much horsepower as the employees of the same industries in Great Britain, turn out, largely by reason of this greater use of power, two and one-half to three times as much production as the English workers, a survey made by the National Industrial Conference Board of New York reveals.

It is estimated that two-thirds of the horsepower used in American industry is electric. The third column of the following table, taken from the conference board's report, shows the horsepower available per wage earner in eight identical industries of the two countries. The fourth shows in dollars the value added by manufacture of what each worker produces in a year.

Industry		Hp. Per Wage Earner	Value Added Per Wage Earner
Steel works and rolling mills..	Gt. Brt.	9.15	975
	U.S.	12.85	3,059
Machinery.....	Gt. Brt.	2.60	997
	U. S.	3.62	3,325
Motor vehicle.	Gt. Brt.	1.13	1,206
	U. S.	2.75	4,096
Electrical machinery.....	Gt. Brt.	1.28	1,198
	U. S.	2.46	3,765
Ship building..	Gt. Brt.	2.70	783
	U. S.	6.04	2,208
Cotton goods..	Gt. Brt.	3.14	725
	U. S.	5.02	1,431
Woolen and worsted goods	Gt. Brt.	1.97	874
	U. S.	3.28	2,164
Boots and shoes	Gt. Brt.	.48	846
	U. S.	.67	2,144

Safety Congress Will Appeal to Thousands

Five hotels will be required to house the 110 meetings, 325 speakers and 6,000 persons expected to attend the Seventeenth Annual Safety Congress to be held in New York City, Oct. 1-5 inclusive. At this congress the question of how to check accidents on the streets and highways, in other public places, at home and throughout industry will be considered.

Meetings will be held in the Hotels Pennsylvania, Waldorf-Astoria, McAlpin, Martinique and Commodore. There will be no charge for admission and non-members of the National Safety Council also will be welcome to attend.

Alfred H. Swayne, vice-president of General Motors and vice-president of the National Automobile Chamber of Commerce, is chairman of the New York Congress Committee.

New British Sewage Power Plant To Be Extended

The gas engine and gas collectors provided by the Birmingham Tame and Rea Drainage Board, England, for the operation of its sludge gas power plant have been in operation since September, 1927. The experience gained during the period of operation confirms the estimates made when the project was adopted in 1926, that the plant, by utilizing the methane gas generated in the sludge digestion tanks at Saltley works, would be capable of producing 500,000 kw.-hr. a year.

The board's present power requirements are approximately 1,290,000 kw.-hr. a year, a figure likely to be increased to 2,500,000 within the next three years. For this reason it is proposed that an extension of the original plant should be undertaken. The projected installation is to comprise a 400-hp. gas engine and alternator, together with the necessary gas collectors, the estimated cost of these proposals being $90,000. When this extension is completed, the total output of the sludge-gas power plant will be increased to 1,500,000 kw.-hr. a year. After meeting all loan charges a surplus of approximately $12,500 a year is expected, calculated on the current charges for electricity.

Coming Conventions

American Society of Mechanical Engineers, Boston regional meeting, Oct. 1-3; second national fuels meeting at Cleveland, Ohio, Sept. 17-20; Calvin Rice, secretary, 29 West 39th St., New York City.

American Welding Society, fall meeting at Philadelphia, Pa., Oct. 8-12; M. M. Kelly, secretary, 29 West 39th St., New York City.

Canadian Steel and Power Show at the University of Toronto Arena, Sept. 4-7; Campbell Bradshaw, secretary, 24 Front St., West Toronto, Canada.

Midwest Power Conference and Exhibition, at Chicago, Feb. 12-16; G. E. Pfisterer, secretary, 53 West Jackson Bld., Chicago.

National Association of Power Engineers, annual convention at Detroit, Sept. 11-15, and concurrently National Exhibitors' Assn. exhibit; Fred Raven, 417 South Dearborn St., Chicago.

National Association Practical Refrigerating Engineers, annual convention at Louisville, Kentucky, Nov. 20-23; E. H. Fox, secretary, 5707 West Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering will be held at the Grand Central Palace, New York City, Dec. 3-8. Address inquiries to the International Exposition Company, Grand Central Palace, New York City.

New England Water Works Association, annual convention at Montreal, Canada, Sept. 18-21, Frank J. Gifford, secretary, 715 Tremont Temple, Boston, Mass.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

World Power Fuel Conference at the Imperial Institute, London, Sept. 24 to Oct. 6.

PERSONALS

TRELL W. YOCUM, one of the executives of the American Petroleum Institute and well known in both the oil and the publishing fields, has been elected managing director of the Oil Heating Institute 420 Madison Ave., New York City, and the American Oil Burner Association. The announcement was made by Leod D. Becker, the present managing director, who has been at the head of the two related organizations since their establishment six years ago, and who, for some time past, has wished to retire from the office so that he may devote all his time to his publishing business. His resignation has finally been accepted by the board of directors, to take effect Oct. 1.

H. SCHRECK, Jackson Heights, New York City, an engineer long identified with oil-engine design, has entered into arrangements with R. Pawlikowski, Gorletz, Germany, whereby Mr. Schreck will act as American representative in negotiations with firms interested in building the Pawlikowski coal dust engine.

BUSINESS NOTES

THE EDWARD VALVE & MANUFACTURING COMPANY, East Chicago, Indiana, announces that it is now represented in Kansas City by the Smiley Equipment Company, 1737 Walnut St., Kansas City, Missouri.

THE MURRAY IRON WORKS COMPANY announced in the August 14 issue of *Power* the appointment of the Wyman-Keagy Company as district representatives. The address of the Wyman-Keagy Company was erroneously given as 1101 Chamber of Commerce Building, Columbus, Ohio, whereas the correct address is 1101 Chamber of Commerce Building, Cincinnati, Ohio.

THE GURNEY ELEVATOR COMPANY announces that its general offices in New York are now at 109 West 64th St., occupying the entire twelfth floor of the building with double the former floor space.

THE DEMPSEY FURNACE COMPANY, INC., 110 East 42nd St., New York City, was recently organized for the design, manufacture and erection of all types of industrial furnaces. This corporation has acquired all the assets, in-

cluding patents, trade-marks, drawings, patterns, etc., of the Dempsey Furnace Division of the W. N. Best Corporation. Dempsey Furnace Co., Inc., will be under the management of H. B. Dempsey as president and commander H. T. Dyer as vice-president, the latter having severed his connection as chief engineer of Peabody Engineering Corporation.

THE JACKSON ENGINEERING & EQUIPMENT COMPANY, of Los Angeles, has concluded additional arrangements for the distribution of Fluor Cooling Towers in all Eastern territory and has co-operated with the engineers of Heat Transfer Products, Inc. of New York, in developing a standard line of heat-exchange equipment for the petroleum industry. These products will be distributed through the Jackson Engineering & Equipment Company, which has recently opened a new office in Room 509, 90 West St., New York City.

THE EDWARD VALVE & MANUFACTURING COMPANY, East Chicago, Ind., announce that their Houston representatives, the Maintenance Engineering Corporation, have moved to new quarters providing better warehouse facilities at 1400 Conti St., Houston, Texas.

THE PAIGE & JONES CHEMICAL COMPANY, of New York City and Hammond, Ind., has purchased from the American Water Softener Company, of Philadelphia, patent rights and good will pertaining to the lime-soda water-softening business of that company and will hereafter manufacture and sell this well-known type of lime-soda water softeners. W. T. Runcie, formerly sales manager and H. C. Waugh, engineer of the American company, have joined the organization of the Paige & Jones Chemical Company.

ERIE CITY IRON WORKS, Erie, Pa., has appointed Alan G. Cary & Company as its sales representatives in St. Paul, Minn. Mr. Cary has been identified with mechanical and power-plant equipment, first with the Robinson, Cary & Sands Company, of St. Paul, for sixteen years, after which he organized his own company to sell railroad, industrial and power-plant equipment.

BUSINESS NOTES

UNITYPE PULVERIZERS—A four-page catalog has recently been issued by the Erie City Iron Works, Erie, Pa., which includes a table of data on its Unitype pulverizer. This table gives capacities in pounds of coal per hour, structural dimensions and shipping weights.

CONTROL FOR STEEL-MILL AUXILIARIES—A new catalog No. GEA-451A, containing 26 pages, on controllers for direct-current mill and crane motors, has recently been issued by the General Electric Company, Schenectady, N. Y. This publication is more than a catalog, as it contains a great deal of useful information on the speed-torque curves of motors when starting; oscillograms of the motors' current during the starting period; and starting under excessive loads.

THREE-DRUM WATER-TUBE BOILERS—The Erie City Iron Works, Erie, Pa., has available two new bulletins on its three-drum water-tube boilers. One of these shows the boiler's construction and the other includes recent installations, which demonstrate modern trends in steam-plant design. These installations are shown by cross-section drawing of boiler and furnace arrangements for burning different classes of fuels.

OSCILLOGRAPH DEVELOPMENTS—Oscillography, S.P. 1796, a recent publication of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., discloses the remarkable progress made during the last decade in the design and application of the oscillograph. In this publication the various types of apparatus, now produced for commercial purposes, are discussed in a non-technical manner. It has a number of illustrations of oscillographs set-up for operation and schematic diagrams which will greatly assist the scientific investigator to a better understanding of the construction and operation.

CELITE FOR CONCRETE—A 16-page bulletin, No. 339, on the use of Celite in concrete, has been recently issued by the Celite Products Company, 1320 S. Hope St., Los Angeles, Calif. This bulletin describes how Celite functions to improve workability in a concrete mix and how the improvement of workability affects the uniformity, watertightness, and appearance of the finished concrete. A discussion of water-cement ratio control and the application of Celite when water-cement ratio control is employed, is also included.

ARC WELDING—In a 32-page illustrated bulletin the General Electric Company shows the application of arc welding in industry. It illustrates the use of arc welding both in repairing old or broken equipment and in the manufacture of new apparatus. In the last few pages are illustrated some of the automatic welding equipment developed by the General Electric Company.

DIESEL ENGINES FOR CENTRAL STATION—As about 17 per cent of the Diesels built each year go into central stations, the development of the engine for this particular field is receiving the attention of various builders. McIntosh & Seymour have just issued a 37-page treatise on its engines applied to central station work. Those interested may obtain a copy by addressing these engine builders at Auburn, N. Y.

EXPANSION JOINTS—The modern increase in steam pressure has made the problem of pipe expansion a serious one. While long bends solve some of the difficulties, the expansion slip joint is a prevailing medium in many office buildings. The Ross Heater & Manufacturing Company, Buffalo, N. Y., has issued a Bulletin No. 133 on the Ross expansion joint. This joint consists of a sleeve fitted to a body and surrounded by a stuffing box. The bulletin contains data as to flange dimensions, illustrations of large buildings using the joint, and in addition information on the Ross heater.

ENGINE INDICATORS—The problem of obtaining accurate indicator diagrams from high-speed internal-combustion engines has always been baffling. Various designs of indicator mechanism have been produced; among these is the Jacklin Engine Indicator, designed by Prof. H. M. Jacklin, of Purdue University. Professor Jacklin has issued a 16-page bulletin showing the apparatus and discussing typical diagrams obtained from high-speed engines. Those interested in this phase of engineering can obtain a copy by addressing H. M. Jacklin, West Lafayette, Ind.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.25@$2.60
Kanawha	Columbus	1.25@ 1.60
Smokeless	Cincinnati	2.00@ 2.35
Smokeless	Chicago	2.00@ 2.25
S. E. Kentucky	Chicago	1.35@ 1.60
Steam	Pittsburgh	1.80@ 1.90
Gas Slack	Pittsburgh	1.20@ 1.30
Big Seam	Birmingham	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.75@$3.00
Barley	New York	1.75@ 2.00

FUEL OIL

New York—Aug. 30, f.o.b. Bayonne, N. J.: 28@34 deg., Baumé, industrial use, tank-car lots, 5c. per gal.; 36@40 deg., furnace, tank-car lots, 7c. per gal.

St. Louis — Aug. 16, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.35 per bbl. or 42 gal.; 26@28 deg., $1.40 per bbl.; 28@30 deg., $1.45 per bbl.; 30@32 deg., $1.50 per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., 4.98c. per gal.

Pittsburgh—Aug. 20, f.o.b. local refinery, 30@34 deg., fuel oil, 5½c. per gal.; 36@40 deg., 5¾c. per gal.

Philadelphia — Aug. 22, 26@30 deg., $1.94@$2.01 per bbl. or 42 gal.; 13@19 deg., $0.995@$1.065 per bbl.; 22 plus, $1.52@$1.57 per bbl.; 27@30 deg., $2.14@$2.21 per bbl.

Cincinnati — Aug. 27, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Aug. 11, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 57½@ 60c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., 90c. per bbl.

Boston—Aug. 27, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.4c. per gal.; 28@32 deg., 5.6c. per gal.

Dallas—Aug. 25, f.o.b. local refinery, 26@30 deg., $1.15 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Corcoran—Corcoran Irrigation Dist., voted assessment of $120,000 to finance purchase of lands and installation of two pumping plants.

Calif., Sacramento—Pacific Gas & Electric Co., San Francisco, has made application to State Dept. of Public Works for appropriation of 525 cu. sec.ft. of water from Bear River in Placer and Nevada counties for power purposes. Plans include dams, power houses, etc. Estimated cost approximately $7,500,000.

Calif., San Rafael—City received lowest bid for pumping plant and outfall sewer from Frederickson & Watson, 354 Hobart St., Oakland, Calif. $82,922.60.

Conn., Hillardville Court (Bucklaud P.O.)—Hilliard Mfg. Co., awarded contract for redevelopment of water power to consist of building of new intake and installation of a 300 hp. turbine and 312 kva. generator in new 22 x 40 ft. power house to Manchester Construction Co., Main St., South Manchester. Estimated cost $25,000. C. T. Main, 201 Devonshire St., Boston, is engineer.

Ill., Chicago — Syndicate, c/o K. M. Vitzhum & Co., 307 North Michigan Ave., awarded contract for a 47 story office and stores building at La Salle and Madison Sts. to John Griffiths & Sons Co., 228 North La Salle St. Estimated cost $8,000,000.

La., New Orleans — Charity Hospital, Tulane Ave., plans the construction of a boiler plant. Estimated cost $110,000. Favrot & Livaudais, Hibernia Bldg., are engineers.

Miss., Oxford — City, T. H. McElroy, Mayor, will receive bids until Sept. 10, for the construction of a 42 x 72 ft. power plant. Frank P. Gates Co., 507 Edwards Hotel Bldg., Jackson, is engineer.

Neb., Gordon—City is having plans prepared for pumping station and filter plant, etc. for sewage disposal plant. Estimated cost $30,000. Henningson Engr. Co., 326 Union State Bank Bldg., Omaha, is engineer.

N. J., Kearny—Delaware Lackawanna & Western R.R., 90 West St., New York, N. Y., is having preliminary plans prepared for the construction of a power house along Hackensack River. Estimated cost $4,250,000. G. J. Ray, Hoboken, N. J., is chief engineer.

N. J., Union—Central Atlantic Ice Co., Park Ave., Summit, will build an ice plant on Morris Ave. here. Estimated cost $80,000. Private plans.

N. Y., New York—American Exchange-Irving Trust Co., 60 Broadway, had plans prepared for a 46 story bank and office building at 1-7 Wall St. Estimated cost $5,000,000. Voorhees, Gmelin & Walker, 101 Park Ave., are architects.

N. Y., New York—New York Edison Co., N. E. Brady, Pres., 130 East 15th St., plans the construction of a sub-station at 68 Dey St. Estimated cost $225,000. W. Whitehill, 709 6th Ave., is engineer.

N. C., Columbia—Town, W. J. White, Mayor, will receive bids until Sept. 10, for the construction of an electric power plant and distribution system.

O., Cleveland — Hildebrandt Provision Co., 3615 Walton Ave., awarded contract for a 1 story, 78 x 82 ft. boiler house and engine room to Boldt-Rapp Co., 5511 Euclid Ave. Estimated cost $40,000.

O., Cleveland—Peerless Motor Car Corp., E. Ver Linden, Pres. and Gen. Mgr., 4614 Prospect Ave., plans the construction of a boiler house, etc., on East 93rd St. Estimated cost $40,000. Wilbur Watson & Associates, 4614 Prospect Ave., are engineers.

Tex., Beeville—Wimer Richardson Co., Travis & Jefferson Sts., San Antonio, has 11,000 acres of land near here which will be sub-divided in plots from 40 to 80 acres each for irrigation purposes to include underground water and pumping systems. Estimated cost $250,000. Private plans.

Wash., Seattle—One Thousand One Hundred Seven Seneca Corp., 1107 Seneca St., plans the construction of a 10 story hotel including automatic oil burning plant, elevators, etc. at Boren and Seneca Sts. Estimated cost $750,000. T. Haire, 33 Henry Bldg., is architect.

Wash., Seattle—Woodland Ridge Investment Co., c/o W. Brust, Republic Bldg., Archt., plans the construction of a 5 story apartment building including electric refrigeration system, electric elevators, etc. at North 53rd St. Estimated cost $500,000.

Ontario — Walkerton Electric Light & Power Co., Walkerton, plans rehabilitating electric power plants at Walkerton and Saugeen and installing complete new equipment to increase output. Estimated cost $150,000. W. A. Emerson, c/o owner, is engineer.

Que., Montreal — E. E. Workman, 445 Cote des Nieges Road, will soon award contract for the construction of a 20 story hotel at Sherbrooke and Mountain Sts. Estimated cost $7,000,000. D. R. Brown, 1111 Beaver Hall Hill, is architect.

Equipment Wanted

Air Compressor, Pumps, etc. — City of Plain Dealing, La., will receive bids until Sept. 11, for one motor driven air compressoor, two 500 g.p.m. motor driven fire pumps, etc., for proposed waterworks improvements.

Boiler, Engine, Refrigerator, Etc.—Bd. of Education, Room 506 Bd. of Education Bldg., 911 Locust St., St. Louis, Mo., will receive bids until Sept. 5 for boiler, engine, heating plant accessories, heat regulating system, etc. for Lindenwood and Kennard schools, also for mechanical refrigerator, etc. for Long and Madison schools. Estimated cost $60,000.

Generator—Supervising Architect, Treasury Dept., Washington, D. C., will receive bids until Sept. 18, for a motor generator at U. S. Mint, Philadelphia, Pa.

Generator Sets, Motors, etc.—U. S. Engineer Office, Chattanooga, Tenn., will receive bids until Sept. 21 for two Diesel engine generator sets, propelling motors, etc., for Diesel-electric towboat.

Oil Burning Apparatus — Schoolhouse Dept., Boston, Mass., is in the market for oil burning apparatus for Gilbert Stuart school, Richmond St., Dorchester (Boston P.O.) Mass.

Pump—City of Chewkee, Okla., one motor driven centrifugal pump for proposed waterworks improvements. Estimated cost $20,000.

Pump—City of Monrovia, Calif., plans to purchase a 1,350 g.p.m. pump for Chapman Wells pumping plant.

Pumping Equipment — Bd. of Public Works, Los Angeles, Calif., will receive bids until Sept. 26 for sewage pumping equipment for North Outfall screening plant at Hyperion.

Pumping Equipment — City of Granger, Tex., pumping equipment for proposed waterworks improvements. Estimated cost $60,000.

Pumping Unit—Dept. of Public Works, J. W. Reid, Comr., Detroit, Mich., will receive bids until Sept. 12, for a 9,000 g.p.m. vertical motor-driven centrifugal pumping unit with electrical equipment and air compressor unit, etc.

Pumps — City of Alabama City, Ala., pumps, etc., for proposed waterworks improvements. Estimated cost $75,000.

Pumps, etc.—City of St. Louis, Mo., L. Day, Comr., will receive bids until Sept. 25, for pumps, etc., for two gravity oiling systems at Missouri River waterworks plant.

Pumps, Engine, etc.—Town of Arnprior, Ont., is in the market for 1,200 g.p.m. gasoline driven centrifugal pump, 1,200 or 800 g.p.m. motor driven centrifugal pump, 150 hp. gasoline engine, etc.

Transformers, Circuit Breakers — A. L. Flint, General Purchasing Officer of the Panama Canal, Washington, D. C., will receive bids until Sept. 10 for transformers, circuit breakers, etc.

Industrial Projects

Ark., Rogers — MILK CONDENSERY — Barnes Dairy Products Co., G. S. Barnes, Pres., Blytheville, plans a 2 story milk condensery here. Estimated cost $200,000. Work will be done by local labor under the supervision of W. C. Easley, construction engineer.

Calif., Richvale — PULP AND PAPER MILL—Pacific Coast Pulp & Paper Co. awarded contract for a group of 1, 2 and 3 story buildings for pulp and paper mill to T. B. Hunt, 1510 30th St., Sacramento, Calif. Estimated cost $1,000,000.

Conn., Fairfield—ALUMINUM FACTORY—U. S. Aluminum Co., Post Rd., awarded contract for a 1 and 2 story, 220 x 470 ft. factory and 30 x 120 ft. office, etc., to C. A. Fritz, Pittsburgh, Pa. Estimated cost $275,000.

Ill., Cicero—METAL FACTORY—Western Electric Co., 11 South La Salle St., Chicago, is having plans prepared for a non-ferrous metal factory here. Estimated cost $3,000,000. Private plans.

Mich., Detroit — DRUG FACTORY — Parke Davis Co., McDougal Ave., awarded contract for first unit of plant, 6 story, 200 x 200 ft. on Jos. Campau Ave., to Otto Misch Co., 159 East Columbia St. Estimated cost $600,000.

Mich., Detroit—CEMENT PLANT—Petoskey Portland Cement Co., awarded contract for the design and construction of two storage silos, 45 x 96 ft. and 40 ft. in diameter for cement plant to Burrell Engineering Co., West Jackson Blvd., Chicago, Ill. Estimated cost $150,000. Equipment including electrically driven elevator and conveyors will be installed.

Mich., Flint—AUTO ASSEMBLY PLANT—Chevrolet Motor Car Co., awarded contract for a 2 story, 200 x 240 and 50 x 170 ft. assembly plant and covered loading dock for automobiles to H. G. Christman Co., Porter Bldg., Lansing. Conveyors and assembly line equipment will be required.

Mo., Carthage—AMMONIA OXIDATION PLANT—Hercules Powder Co. awarded contract for the construction of an ammonia oxidation plant to Chemical Construction Co., 50 East 42nd St., New York, N. Y. Estimated cost $300,000.

Tex., San Antonio—CEMENT PLANT—Republic Portland Cement Co., J. H. Smith, Pres., plans the construction of a cement plant, 1,000,000 bbl. annual capacity near here. Estimated cost $2,500,000. Terrell Bartlett, Calcasieu Bldg., is engineer. R. K. Meade, 10 Chase St., Baltimore, Md., is consulting engineer. Contracts have been let for kilns, mills and coolers, also for the installation of all electrical equipment.

Ont., Hamilton — STEEL PLANT — The Steel Co. of Hamilton, plans to spend between $6,000,000 and $7,000,000 on plant improvements, beginning in 1929 and extending over a period of two years. Plans include replacing the present 14 and 10 in. rolling mills with complete modern 12 and 10 in. equipment, extending and improving blooming mill, soaking pits and water supply, also to build immense ore and coal unloading docks and equip with modern equipment. Company engineers in charge.

Ont., Toronto — PAPERBOARD MILL ADDITION—Canadian Paperboard Co., Ft. of Carlau Ave., awarded general contract for 70 x 320 ft. and 162 x 252 ft. addition to paperboard mill to W. J. Tremble, 73 Adelaide St. W. Engineer will award steam heating and ventilating system. Kerr & Chace Ltd. Confederation Life Bldg., are engineers.

Ont., Toronto — PAPERBOARD MILL ADDITION—Hinde & Dauche Paper Co. of Canada, 43 Hanna St., plans the construction of a 1 and 2 story addition to paperboard mill including steam heating system, etc. Estimated cost $500,000. R. Cook, 43 Hanna St., is engineer. Equipment including electric motors, pumps, shafting, etc. will be required.